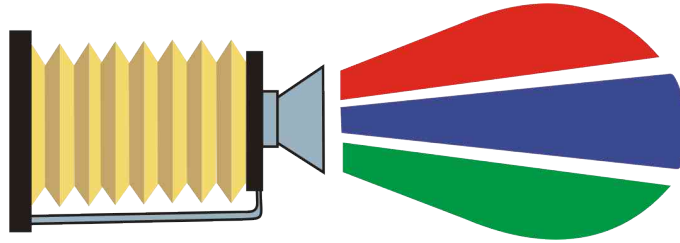


D&A Rubio Stereo 3-D



Stereoscopic 3-D Cinema



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Second Revision 2.0 (April 4th of 2012)

This book was started on Tuesday **December 6th of 2011** 2:30 pm. CST

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I want to dedicate this book first and mainly to [Jehovah God](#) whom created the [Universe](#) three dimensional and gave us the best 3-D system to appreciate it, our vision that consist of our eyes and brain. And **He** was also who gave me the wisdom to “figure it all out” regarding this system, that even though is “simple” as our own vision system apparently is (we don't give it too much thought, we just use it and that's it for the most part) it works not as well as our vision, but is still "workable".

Also to my beloved sons, whom were a **gift** from Jehovah to me as well, **David** and **Alexander Rubio** (D&A Rubio).

And lastly, to all the people who **love** Stereoscopic 3-D Cinema.

Cesar Rubio.

The Universe which is a reflection of its Creator.

[Pillars of Creation](#) photograph taken with the Hubble Telescope, by **Jeff Hester** and **Paul Scowen**



D&A Rubio, the greatest loves of my life



Before going any further, I want to apologize if my way of writing things is not perfect; English is a second language for me. And even in Spanish my native language, I am very bad in orthography and articulation...English is the “universal” language for world wide reach communication, so its' proper that this e-book is in that language because I want to reach to the most people I can no mater where they live in our beautiful home the Earth. Also English is the native language of the two human beings I love the most in my life, my beautiful boys **David** and **Alexander Rubio**.

I suffer from bipolar disorder and have extremely bad memory, (just important events in my life I never forget...and the rest of the info I know is there “some where” in my “hard drive”, but I have a really bad “search engine”...slow and sometimes it takes me days, months or even years to “find” (remember) certain information stored in my brain.

Most of the time I have to read, watch or listen to things many times in order to understand them and to finally “copy” them in my brain. I am especially bad with names of persons, that is the worst mistake anyone can make when meeting and dealing with people! Please forgive me if I have forgotten your name.

Because of that I tend to be "repetitive", not that I do it in purpose, is because I have forgotten that I have mentioned it before. You might find some of that in these writings. Sorry, I will try to correct it as much as I can...

So having those things into account, some of my original “feelings” and opinions of some of the information in this book might have changed since I originally wrote them. We all human beings do that all the time don't we? Live and learn...and learning some times makes you change...sometimes.

Some times it might seem that I “contradict” my self too, please try to see the BIG picture and the context of things, we humans are the most “complicated machine” ever built, and many times we don't even understand ourselves, so how can we expect others do understand us all the time?

A good principle to apply in all human communications is something I read once in the internet (not too long ago) when someone mentioned that when he reads something he tries to understand **what** made that person say (or do) that instead of judging that person words (or actions) too simplistic...good one right? I bet you that even judges and juries would make fewer mistakes if all of them applied this principle.

Also since all information needs to be “doubled checked” for accuracy, especially when writing a book, I need the internet (and more time) to check for many things I say here...but I don't have access now nor much time, so most of the things here come from documents I already have saved, and some “up to date” info comes from my memory and further reflection on the matter...please forgive me for some errors you might encounter in this book, I am just a human being like you, imperfect.

Also all books need to be re-read and extensively reviewed over time...being a writer is hard work and takes time to do it right! Also asking others to read it before “publishing” it is not a bad idea either, people you can trust and are knowledgeable on the subject that can make suggestions for editing or adding extra info.

But Like I said, I ran out of time and can not do that now. If you read this book, you will be the “beta tester” and final “user” of it.

Sorry but certain things in life are this way, whether we like it or not...

The good part is that this is a small book (or document better said), and I hope you can find useful information here.

One day I might review it and make a “second edition” of it...with probably more new info, if I can not do that for some reason, you are welcome to take it “from here” and continue with this project research and writing of the book. Or add some of the info here in your own book, please see the copyright disclaimer at the end of this book. Thanks, CR.

Hi, my name is **Horacio Cesar Rubio Sanchez**, I was born [July 26th of 1971](#) in [Guadalajara, Jalisco Mexico](#). I am more known as “Cesar Rubio”.

I am a Professional Photographer and Videographer who loves Stereo 3-D as well!

I fell in love with 3-D when I saw my first [View-Master](#) reel when I was 7 years old...back in **1978**. 33 years ago.

I started doing Professional Portrait and Event Photography in **1989**. When I was only 18 years old, that year I opened my first Studio in Guadalajara with \$500 Dlls I borrowed. I don't know how I was able to do that with so little money...being “creative” solves many problems when you don't have lots of money at your disposal.

I bought an old large format 4x5” camera, I don't remember exactly the brand now...I should have not sold that camera. I would pay a fortune for it today if I had the money! (I tried to build one before buying it, and had most of the things ready but I “postponed” the project when I realized that I did not have the proper tools to finish the job by myself, one day I hope I can finish that job though...since I don't like to give up in anything, just to take breaks that's all).

I had it "restored" to almost "new" condition by an old man...oh boy it took more than a human being takes to be born from the time is conceived! More than 9 months...maybe a year? I don't remember exactly but what I do remember is that I waited for my "baby" a long time...I paid a lot of visits to the "doctor" to see how things were going...but when finally it was "re-born" again, all the time and sacrifices were forgotten when I saw that beauty. Seeing it, it was almost like seeing my future Photography career...without a camera how could I have started it?

I bought a 210mm lens for that camera that did not work either (had a missing shutter curtain among other things), I send it to be restored also, I made my own lights, most of my darkroom tools, painted, put new wall paper and decorated the studio, I even made the division “walls. And finally I made the exterior sign.

I did most of that while I was waiting for my "baby"...just like parents do when waiting for their babies, they decorate a room for he or she, buy things that they know that will be needed...and the best of all, they **dream** with that moment to happen, they are **happy** and have **faith** that everything will be alright. And when that moment finally arrives, is one of a kind moment in life isn't it? Can you forget when your first or any of your other children were born? Not me, they were some of the **best** moments of my life when I saw, hugged and kissed my two beautiful boys for the first time.

And most importantly of all, I self thought my self B&W Photography through experimentation (I only saw a few times a couple of photographer how they did it in their Studios before).

When I finally opened my studio for business, one day not too long from the "grand opening" date, someone took a SLR 35mm film camera to my studio and offered to me for sale, it was a [Yashica](#) camera, it did not work either, but it was cheap and I paid 80 pesos (like 7 dollars).

I had it repaired too and that was my first SLR camera! I learned a lot with that camera, although the non rechargeable batteries were really expensive! That camera served me well for many years until I could afford another one that did not need such batteries to work (at least only the small battery for the exposure meter) I think I still have that cam somewhere...

My own studio was the best "School of Photography" for me. Especially since I have never attended one! :-)) I will never forget those beautiful and exciting times for me. Then later on, I bought some books about Photography, I should have done that first! (But sometimes I am “backwards” in doing certain things...)

Then in **2003** I started doing Professional Event Videography. Self thought that myself as well. It was hard to make a “simple” DVD for me at the beginning! I love the [Panasonic DVX-100](#) and **Pinnacle Liquid Edition** (LE) video editor starting since version 5, and all the people in the LE forums especially **Lew S.** a great moderator guy (later on that software was changed to Avid Liquid Edition).

In **2005** I started experimenting with 3-D Photography (first with a couple of 35mm SLR [Nikon FM-2](#) film cameras, and then later on with two [Nikon D70](#) DSLR's cameras, and since 2008 with two [Sony A-300](#) DSLR's)

In the summer of **2006** I started experimenting with 3-D Video using camcorders (with the Panasonic **DVX-100** and **DVC-80**). But since I've got "subpar" results at best, I started looking for better equipment to record 3-D video.

That led me to my research with **Machine Vision Cameras** (MVC's), AFAIK I was the first one to propose the use of such cameras for 3-D Cinema and 3-D HDTV Cinema style productions.

Now MVC's are used in Motion Capture 3-D (mocap), and Stop Action 3-D all over the world. Live Action 3-D is the field where they are starting to have more "acceptance", especially as recording systems are getting smaller.

Note about **computers**, I started working with them back in **1996** but only to capture some sales data as I was a sells/delivery man of the largest bread manufacturer in Mexico, **Bimbo** (I started working there when things got really bad in the photo biz in 1994).

Then in early **2001** I learned to use the **internet** in the **Jefferson Wisconsin Public Library** (I love all the staff there). I also checked out VHS movies there every weekend. I will never forget some of the movies I watched that year. One of them was "**Cast Away**", and "**My Life**" two of my favorites of all time.

In late 2002 I bought my first desktop computer, an **HP**. Then in 2005 I started building my own computers by myself. Self taught how to do that as well. I never looked back, self building things is more rewarding than it seems at first sight. And it's worth the "trouble".

Regarding Stereo 3-D I am not an expert, there are a lot more people out there with better knowledge than me about the subject, I am only an average "Joe" that loves 3-D images and aims to make a Professional Uncompressed Raw 3-D system that is affordable for people like me. I can be cataloged as a "system integrator" and not as an inventor since I have not invented anything...all are inventions of other people and companies. I just thought that MVC's could work for 3-D Digital Cinema acquisition that's all...and it seems that I was right since they do! :-)



Me in 2009 in the best office, studio and "lab" that I've ever had, my home.
(near **Cambridge Wisconsin USA**.)

All these need to be checked again since I am getting those “out of my memory”, and I have a really bad one! So don't take all of these as “set in stone” and look for extra info in other places too. Others might give another explanation...But I'll try to explain simple, some of the most important terms that I use in this book.

Beam Splitter: Sometimes called “Mirror Rig” too, that helps to reduce the Stereo Base, mostly used with cameras that are not narrow enough for a side by side camera placement.

Convergence: Sometimes called “Toe-in” too, where you point both cameras or lenses to your main object/subject when recording Stereo, so they can “converge” at that point. But doing this causes keystone distortions in the background.

Horizontal Image Translation (HIT): A method to set the Parallax values in post when shooting Parallel Stereo.

Keystone Distortions: Distinct perspective distortions, caused mostly in the background when shooting with converged camera or lenses. They are difficult to correct in post.

Machine Vision Cameras (MVC's): Cameras used for Digital Motion or Still Pictures capture, more commonly used for manufacturing inspection and quality control, among others fields like scientific, medical, military, surveillance etc. Now also used in recording “Street Views” in maps like Google Earth and others. Also MVC's are used in 2-D & 3-D Cinema capture too.

NetD: Net Deviation. Separation between the right and left sides, usually measured in percentages.

OLPF: Optical Low Pass Filter, a filter used on top of the sensor (for the most part) to “soften” the images a little bit to minimize aliasing and moiré.

Ortho Stereo: The 3-D effect as close as our eyes see things in real life, accomplished by a 65mm Stereo Base.

Parallax: Positive is where the objects appear out of the screen plane, and Negative when they appear inside the screen.

Parallel Stereo: Parallel placement of cameras or lenses.

Progressive Recording: Digital Capture of images, where the information is recorded in one single “frame”.

Stereo Base: Distance from center to center of lenses in a stereo camera.

Side by Side: Placement of two cameras (or “heads”) for Stereoscopic recordings.

Uncompressed Raw: Non in camera processed Digital Uncompressed Capture.

You can find more Stereo definitions on my good friend [Al Caudullo](#) website: [3D Guy.tv](#)

Ok, this is kind of hard. Because I am actually writing this at the end of having almost completed this book...and it should have been the other way around correct?

[Matt Beck](#) an American dear friend of mine, who is extraordinary intelligent has told me that I do this kind of backward thing when I speak or write in English, and that makes sense since the phrasing and structure of the Spanish language sometimes is the "opposite" of English...sometimes it's kind of hard to interpret perfectly Spanish-English and vice versa, since some of the meanings don't "make sense" the same way in both languages. So being "bilingual" is kind of difficult by itself...

And Stereoscopic 3-D Cinematography is also extremely difficult since there are two, or even more "schools of thought" for most of the issues when recording it. Some times they "contradict" each other too...

And on top of those two things, my old "habit" of going backwards sometimes when doing certain things...as I already explained when I started in Professional Photography.

Maybe I need to "unlearn" that old habit of mine, to be able to start "new" again (I don't remember when I started doing it though...I think since I was a little boy).

So I don't know if it's a blessing or a curse...trying to be bilingual, loving Stereo 3-D still and motion images, and some times finishing where I should have started.:-)

No wonder most see people who have made significant discoveries in life as "crazy"...because **you must be** in order to "defy" many conceptions that most people follow...and trying to go "deep" into the root of things as much as you can go is sometimes dangerous, that only the crazy dare to do...

Not many are very fond of navigate into unknown "waters" either...remember [Christopher Columbus](#)? Most people thought that the Earth was plain, square and that it had an "end" back then...

Even not knowing that for sure, he took the risk with his ships that may "fall" into a deep darkness at the end of the world...scary thought especially at night when they could not see much in the distance. How were they able to sleep at night during their trip? Would you be able to have "sweet dreams" when in "any moment" the ship could sink into darkness, finishing your life in the way?!

And what he found after having thinking about the issue carefully, maybe for years and with all his knowledge he had acquired during his whole life, convincing the Kings of Spain for financial resources to be able to fulfill his **dream**, and later on during the trip controlling his own **fears** and the ones of his crew?

The end of the world, or a "new one"?

So maybe it's not so bad that I finished with this chapter thinking it more carefully, because writing this book has being an extraordinary experience. It's kind of a "diary" that I never wanted to do before...to write my thoughts...it's kind of scary for most people! Trying to put your mind in "order" is not so easy...especially if you are kind of "crazy" like me.:-)

But since I started participating in internet forums regularly (by the end of 2005) I have gotten a little bit of experience trying to communicate my thoughts by now...try to "structure" them, and even doing that sometimes it's still difficult to get "my point across". But most people who know me well, know by now how to "interpret" what I am trying to say...

Writing this has been kind of a "ride" for me. Going through things I thought and wrote before, and new things I have learned during these past 5 years, and trying to mix them together for the best possible result.

While writing this book I tried to be the most unbiased possible or "neutral", as my human nature permits me (and I am very imperfect)...

Being polite and having a sense of "diplomacy" or "political correctness" has definitely its place in human relations and communications...But at the end of the day what it counts, is what YOU like and what makes YOU happy.

So, after everything is said and done, I have chosen "my side" regarding my likes for Stereoscopic 3-D Cinema capture. And now while I read the book for the first time, I might do some changes reflecting my preferences...

I hope that here in this book you will find information about the things I like and into why I prefer them, but if you are not a patient person (how can you be any good not being so?) and won't read the 150 pages or so of written information, here they are for the kind of "fast food" people...but here the "food" it's not junk, is actually a "fine dinner" prepared in 5 years by a "chef" with 22 years of Professional experience, with a fine wine "reserve of 1971", served it fast.

Would such dining experience be considered cheap?

Take it as a **3 minutes** "free consultation", 2 minutes on my part, plus 1 minute wait for you to make your choices if you will...3 minutes total is what I can give you for **free**, tops :-). Sorry time is money, and I need it since I have not being officially "working" for almost 2 years now...:-)

Yeah right, you can read these in 2 minutes, but deciding is not so easy...you have to read the whole thing...do your own tests and **think twice** or more than that, maybe through out all your Professional career as **Stereographer**, as you might be experiencing new things and have to compare/mix them with your previous conceptions...

I do that all the time too. It's **fun**, you will never have to leave "school" again in your whole life! :-)

My 10 Preferences for 3-D:

- 1- Live Action.
- 2- Side by Side camera placement.
- 3- Parallel Stereo shooting.
- 4- 3.3% NetD
- 5- 2/3" (inch) Depth of Field (DOF) format.
- 6- Uncompressed Raw recordings.
- 7- 60p* (progressive frames) capture.
- 8- Minimum 33mm Stereo Base in a side by side rig, achievable today with some camera heads and lenses sizes.
- 9- 28mm, 42mm and 85mm FL's (Focal Lengths) in Full Frame (FF) 35mm terms.
- 10- 2K-3K Resolution (for the cameras specifications, workflow and price. As of today).

*Although I like 60p, at this time 24p is a better option for Uncompressed Raw for the Indie 3-D movie producer.

Please don't think that since I like all of these things I will push them for you too, in my 40 years of life I have realized that the only person I can influence for changes is myself...and most of the time I even fail into "obeying" the "inner me"...But I might setting them as the "standard" point in the middle, from there you can go to the "left" or to the right" as you please.

So if you are reading this, is because you are an intelligent **thinking** person, take what you like and throw the rest that you don't like aside, not BIG deal, we can still be "Amigos" after that, right? :-)

-Machine Vision Cameras (MVC's) for 3-D Digital Cinema capture.

It can be said that **we** are the most sophisticated MVC's 3-D System that exist. Why?

Because we are the best "**Machine**" ever built, and we have also the best **Vision** System that "coincidentally" is **3-D**, and we have the best "**Camera**" system that records everything we see...our Brain.

Even if you don't remember certain things you've seen before (due to poor "memory" usage, non "fragmentation of your disk", or a plain bad "searching engine" :-)), oh yes all the info is there for you to "retrieve" one day if you want to...something's are better in the "Recycle Bin" though. You can "empty it" if you want to, but unless you are fully "formatted" again, everything is still there...even the "hidden" things...

Some people leave the "best" for the end in books or stories (applies to movies as well of course)...I will do kind of that too, with my proposed **Stereo Vision 3-D Digital Cinema** System, but after explaining the purpose of this project and do a little bit of research and study on 3-D capture techniques. By half of the book I will tell you something you can use now for 3-D Digital Cinema capture (2K/24-60p), today not tomorrow. Just a "cut to the chase" kind of thing in the "2K Cinema Bayer" chapter. 4K camera heads are coming soon...in late **2012**.

I proposed the use of MVC's for 3-D Cinematography (3-D HDTV Drama, and Commercials applies as well) in **2006**, basically for these reasons.

Advantages:

- 1- They are small and permit a side by side configuration.
 - 2- Two separate camera heads permit a variable Stereo Base (SB), a key ingredient for good Stereo work, current 3D camcorders fail in this single important issue (having a fixed SB).
- To be able to change SB we need a stereo slide bar, like some of the Jasper's that are beautiful made.
- 3- They can be perfectly synchronized. This is very important as well, and most consumer camcorders and all of them (until now) DSLR's fail to achieve this.
 - 4- You can record Uncompressed Raw video with them (neither camcorders 2-D or 3-D, and DSLR's can't do this at present time...only a few Cinema cameras can do it)
 - 5- Easy interchangeable lenses, with sealed inside body parts to avoid getting dust in the sensor while changing them. Like shown here:



The only thing separating MVC's from “Cinema heads” is the use of an **OLPF** ([Optical Low Pass Filter](#)), that reduces aliasing and moiré in images. At this point and until manufacturers offer it as an option, if you plan to show your movie in a 2-D version too, you will have to find an “after market” solution...just like some people do with their DSLR's when recording video.

This is not so much of an issue in the 3-D movie, because the combined 3-D projection or monitor display technologies (3-D HDTV and 3-D Computer), increases the final perceived resolution and that makes up for the aliasing very nice while keeping the most resolution possible!

I think that cameras not having an OLPF, is actually more beneficial for 3-D 2K resolution!

Disadvantages:

1- Small size...What?!

Didn't I say that it was the number one reason that I like them for 3-D? Yes, but being honest some tiny MVC's bodies can not dissipate heat as well as a bigger body camera head. And what heat causes? Noise in the sensor, and hence in the output images.

Because of this issue, some MVC's offer an air cooling system. An integrated fan plain and simple. But that causes two problems also...first the body size needs to be bigger, and second audible noise. My God how can we get rid of the two noises (visual and audible) at the same time and without making the camera bigger?

1- Maybe with a liquid cooling system like some use for computers?

2- A "heat sink" or piece of metal in top of the cameras. The bottom tripod mount helps in this regard a little, but it's not enough.

3- A large (and silent) fan on top of both cameras (at least a 120mm variable speed computer fan).

4-All of the above combined.

I am pretty good into falling in love at first sight (with persons or things), and when I saw a Beam Splitter (BS) rig (some times called “Mirror Rig”) the first thing I thought was: “seriously? Do I need that thing for Stereo recordings?”

Besides aesthetic looks, they also introduce a lot of problems and the main ones are these:

Beam Splitter disadvantages:

1- They “rob” a 1 1/2 to 2 f-stops of sensitivity in average vs side by side camera configurations. The best ones claim only 1 1/2 f-stop...but even that is one and a half less sensitivity.

2- They produce different “look”, or color “cast” in both video sides (due to the mirror).

3- The mirror is prone to get dust.

4- Upside down camera orientations produce different “reading” of the sensors, especially with CMOS with Rolling Shutters (not Global Shutter). Experienced Stereographers like [John Rupkalvis](#) (JR) who is a friend of mine, and have used them with such cameras, say that is a noticeable issue in the final Stereo footage.

5-It takes considerable time to align both cameras in a BS rig, and to change lenses after that...even 10 minutes is an “eternity” (analogy taken from the movie **Cast Away**:-))

That's why most use zoom motorized lenses with BS rigs, to avoid the time consuming task of changing prime lenses and align the rig every time while doing so. But those zooms and motorized mechanisms are not cheap! And require motors and cabling like crazy all over, at least 3 of each per zoom. 1 for lens aperture, 1 for zoom range and 1 for focusing. 6 motors that will eat batteries more than a hungry child eats in a hospice.

A cheaper approach is to get camcorders that show precise zoom ranges with numbers, like the Panasonic DVX-100 camera does, that way you can match both lenses FL's more easy. But that does not work in the "fly" kind of 3D shooting style.

But you still have to deal with iris (lens aperture) and focusing, individually if you prefer manual settings.

6- BS are heavy and bulky for the most part, and the best ones minimizing those problems cost a mini fortune...more than the cameras! How about that, a piece of metal costing more than a couple of complicated system of electronics (Cinema cameras)...am I having a nightmare, or this is for real?

What else? I will leave it at that for now....if you have used them you know better than me other shortcomings.

Even though I still don't like them very much, I realize that they are necessary for certain work, but I want to use them as little as I can...like for example in 1% of my work or even less than that if I can. I would use them just for extremely tight close ups and macro work (unless the movie is complete macro work or contains lots of those shots of course, I will be using it more than 1% of the time).

But for more "normal" 3-D Cinematography, how can I shoot side by side 99% of the time?

For this info go to "Cinema 2K Bayer/Equipment/Workflow/Shooting".

For most of the acted work we need 3 prime lenses, a wide angle, a "normal" and a mid telephoto.

Even this **Squirrel** knows that. Since is so intelligent, maybe is "Sandy" from [SpongeBob](#)? :-)



I don't recommend long telephotos for Stereo because they cause "card boarding", where the subjects and objects seem like "cut-outs" plain characters.

And that is understandable because telephoto lenses compress the images, and if it wasn't for the out of focus backgrounds, they would "fuse" with the foreground. I don't think that there is a "work around" for this optical "phenomenon"...but who knows, never say never...

So with long telephoto lenses there is no "3-D" there my friends (at least a good one), and if not then why bother with it? Just shoot 2-D and you will be better off!

That's why I don't think that for the time being 2-D is not going anywhere anytime soon. And 2-D to 3-D conversion is here to stay too, for those kinds of shots and other difficult ones.

Ok, so I need my 3 prime lenses with these FL's (Focal Lengths) preferably, a 28mm wide angle, a 42mm normal and a 85mm mid telephoto (all FF 35 mm equivalents) for most of my work, now what optical format to choose from?

The largest that would permit to work side by side with the mid-telephoto lenses (given the size of some MVC's bodies and lenses) is the 2/3" (inch) format. 4/3" and S35mm formats are also workable for the wide angle and normal lenses, but not for the mid-telephoto. You will need a BS rig for those. But rather I would use the 2/3" cameras and lenses since those shots don't need too much resolution.

I also prefer the 2/3" optical format because of the deeper Depth of Field (DOF) it offers. See the "DOF and 3-D" chapter, for more info on this.

In all of those format sizes (2/3"-S35mm), they permit a decent individual pixel size in a traditional Bayer sensor design. Like 5.5um (microns) pixel size, want global shutter in CMOS sensors, good sensitivity and dynamic range, avoid lens diffraction, etc? Then that is the "Pro" pixel size (for the time being).

I need my lenses diameter (the mid-telephoto especially) to be the narrowest possible, like 33mm would do just fine.

The increase of resolution in a 2/3" Bayer sensor without making the pixels smaller is an "easy fix", how? With a diagonal pixel sensor design like in the [Fuji S3/S5 DSLR](#) cameras. (or "Zig-Zag" design as Sony calls it) that would "quadruple" the resolution from 2K to 4K. Just like the [Sony F65 camera sensor](#). But here we need the complete Bayer sensor output (not the "super sampling" approach the F65 uses).

Yes I know that the F65 approach gives better output resolution "out of the bat", but with a good de-Bayering (or demosaicing) process, traditional Bayer resolution is not so bad as some want you to believe.

But I don't know if such design would permit global shutter in CMOS, maybe not since the F65 has a mechanical shutter to minimize the rolling shutter problems of traditional CMOS sensors.

So maybe it has to be a CCD design instead, but that would probably limit the frame rates. I can be "happy" with a 4K/24p or if possible a 4K/60p CCD for a long time to come. For slow motion 3-D (higher frame rates) I could use 2K resolution with a CMOS sensor (global shutter) camera, there are already some heads that can do 2K/340 fps for \$1500 USD! Incredible price!

Combining all that, let's do first some homework learning the basics of Stereo 3-D before we "get to work" with equipment that is already available, and some that is coming to market very soon. Instead of waiting years for the "perfect" combination solution...while this system is targeted for 3-D Cinema, it can be used for 3-D HDTV drama and commercials productions as well (not live).

At this point there are only a few 2K/1080p resolution MVC's available (that run at least at 60 fps in full resolution), there are also some 3K Kodak 4/3" CCD cameras that can do at least 24fps at slightly less than 3K resolution. And there is a Dalsa 4/3" CMOS camera that can do close to 120 fps at 3K resolution!

In the 4K resolution camp we have a camera with a S35mm CMOS sensor from Dalsa that can do 4K/60p at least (more like 4K/72p tops). And soon there will be the first offerings of MVC's with a [CMOSIS 4K sensor](#) that can do more than 300 fps at full resolution! I don't think that there is a camera-recorder interface fast enough to carry all that Uncompressed Raw data, and there are not yet portable recorders that can record that either.

So like a mentioned before, for such Slow-Mo 3-D work you can use two 2K camera heads/ 2 recorders combination like the IO Industries DVR Express Core (with Camera Link Full plus interface) that can do around 2K/300p Uncompressed Raw 8 bit.

24 fps is the minimum we need for regular Cinema, but the aim for the future of 3-D Cinema is 60 fps. You can make a complete movie without a single slow motion shot, If the story doesn't call for those kind of shots (and even if it does but previous "chapters" did not use those) almost anybody will say at the end: "hey, I liked the movie but what happened to the Slow-Mo scenes?" Unless is the Matrix or similar movies of course! :-)

After you learn the basics, then you can now go to the "2K,3K to 2K finish and 4K Cinema Bayer" chapters to see the equipment you will need.

But before all of that, like in good stories lets do some "background check" of this project, and the "State of the Nation" regarding other approaches for 3-D motion pictures capture today.

So happy learning "boys"! And like I always tell my boys when they are leaving to school: "Have fun at school" ..:-)

And while you are at "school", like [John Lennon](#) said in the [Beautiful Boy](#) song, don't forget that "life is what happens to you when you are busy making other plans".

I started working in this project in the fall of 2006, because my previous “tests” of recording 3-D video with camcorders were not satisfactory enough.

This is a post that I wrote about those problems in the forum that I dedicated to my firstborn son **David Rubio** (www.davidrubio3d.com) Now offline.

You can still see parts of the forum on the Internet [WayBack Machine](#).

It was posted on Monday **Dec 4th, 2006** at 08:25 am (CST- USA Central Standard Time).

You can see the whole archived discussion here:

http://web.archive.org/web/20090123094735/http://davidrubio3d.com/view_topic.php?id=41&forum_id=5

Problems of 3-D Video Recording with Camcorders

My first 3-D videos were made with a [Panasonic DVX-100](#) & a DVC-80 camcorders (same cameras but without the progressive modes of 24p & 30p on the DVC-80).

The problem that I have encounter with a set-up like this is: (also applies to most camcorders)

1-The Stereo Base, (center to center distance between lenses) is more than the desired 6.5cms (ortho stereo) and at 13.5cms (from center to center of the lenses) it gives hyper stereo 3-D, that makes scenes and objects appear like if they were "miniature" and the observer a "giant" looking at a smaller world.

Even when this particular problem does not affect small camcorders read the point no.5 please.

2-Interlaced Video Recording, most consumer & prosumer camcorders record interlaced video and even the ones like the DVX-100 and a few others that have this feature, its not true progressive and record NTSC video at 29.97fps with a complicated method of conversion to 24p,30p & 60p.

Interlaced video is OK for TV's because they were made to display that kind of video.

3-D video display in a regular TV set has the problems that at 60Hz (30fps x 2 fields=60) has to alternate 30fps for each eye, and that produces unacceptable flicker and reduces the vertical resolution in half.(instead of 480 you get 240 lines for each eye).

Even when I've used VirtualDub to de-interlaced video, it has it's limitations and the resulting video it's not true progressive for a correct display with projection and PC playback (the movements of people and objects do not seem to be natural)

See more info about progressive vs. interlaced video [here](#).

3-Compressed Video Recording, all camcorders (except for a few high end ones) compress the video right on camera and the final video output has little to none room to make proper adjustments without degrading more the final quality. Even when video has to be compressed in order to fit on DVD, HD-DVD & Blu-ray Discs for media distribution, it is better to do so in post-production (after the video has been recorded & corrected).

All Professionals know that shooting in [RAW](#) mode uncompressed or with [lossless compression](#), the original source of video keeps "pure" to make fine adjustments like color correction, white balance, sharpness and others in post after shooting the video and not on the field where time constrains & proper equipment does not permit to do so properly, more info in RAW files [here](#).

After the video has been properly adjusted, then it can be compressed (render) for distribution on the previously mentioned media and including internet distribution (highly compressed).

If you wonder why film movies look so good (even on DVD) is because film is the equivalent of raw (or vice-versa) and contains all the recorded info that has plenty of room to make corrections in post.

Even for still digital photography, RAW is the way to go to make corrections and have plenty of room to adjust those photos that were not perfectly exposed due to not having time to make camera adjustments because the moment required to "shoot it or lose it" kind of spontaneous moments that happen only once without posing or acting them, or for mistakes made by the photographer when not choosing the best camera sets for a particular shooting environment.

I always shoot in NEF+JPEG (Nef is the Nikon definition of their RAW mode) so I have the JPEG file to show and review all the photos and RAW to make adjustments in Photoshop CS2 to the final pictures selected for printing.

4-Camera Synchronization, even using LANC controllers to start recording both camcorders at the same time, the tape mechanisms will start loosing sync (sometimes after a few seconds depending on the camcorders) and the resulting video will be with not exactly matched frames and each eye seeing different delayed display of a scene...not very pleasing to watch.

Even when I think tape has it's virtues like a proven durability to storage data over the years without loosing it, I like to do so after I capture (with my AVT cameras) and edit my footage.

After capturing & editing RAW video I can render my final video to any codec like Panasonic 25 Mbit/s to transfer my final material to tape directly from my timeline (on my video editor) for long time storage.(one stream of video at the time)

I also can render to MPEG-2 at different compressions for use in the Stereoscopic Player for dual projection through my HTPC (Home Theater PC) and at lesser bit rate with DviX for web distribution.
You can use the codec of you preference for any given circumstance.

You can also make standard DVD's of the right or left video to watch as a regular 2-D video on your TV.

Even 3-D DVD's can be made, I have not tried to make one yet and I don't even know if they can be made in true progressive mode (all the 3-D DVD's that I have knowledge of are Interlaced)

5-Weight of Camcorders, even though the small consumer camcorders are light in weight and permit to use a proper stereo base, the size of the CCD or CMOS sensor is what it matters most and not the size of the camera itself. Most consumer camcorders have a 1/8" sensor and at that size it gives really bad low light performance (scenes look too dark).

To get a decent low light performance a 1/3" size sensor is needed at least, and that is in a SD (Standard Definition) camera, for HD (High Definition) even a 1/3" sensor will give bad low light performance due to the individual pixel size reduction in order to accommodate more pixels in the same area. See it this way:

Lets say that we fill a bucket (pixel) with water (light) when it's raining, the larger the bucket the more water will retain in comparison to a smaller one at any given moment (exposure).

In the 2-D video field I have seen big camcorders used by some people that have a single 1/4" sensor, but since they look more "professional" and the price often is less (like \$2,000 US Dlls.) than a 1/3" 3-CCD camera, they go into the business of recording events like weddings & others, charging more money than their camera actually cost brand new & misleading poor customers who have little to none knowledge of what a good video production requires.

Conclusion:

Until now, tape recording with camcorders has been the only medium for recording video in 3-D on the consumer market.

But now we have the opportunity & the benefits of recording better 3-D video with other cameras like the ones used in the Machine Vision Industry, not only for consumer display in the comfort of our homes but even for professional distribution for mass display in Digital Cinemas.

This was the main topic about my 3-D project involving Machine Vision Cameras, on my son's forum "David Rubio 3-D". And it was posted on **Mon Dec 4th, 2006 12:12 pm (USA-CST)**.

You still can see the whole archived discussion here:

http://web.archive.org/web/20090123140707/http://davidrubio3d.com/view_topic.php?id=43&forum_id=44

After reading the topic "[Problems of 3-D Video Recording with Camcorders](#)" you might be asking why machine vision cameras are better?

This is why:

1-Variable Stereo base, with most machine vision cameras (MVC) having a small enclosure, the stereo base (distance between the 2 cameras measured from center to center of lenses) the minimum distance can be even 4cms., more than the 6.5cms. for recording normal 3-D (Ortho Stereo) and mounted in a slide bar they can be separated as needed for different requirements like recording distant or big objects in 3-D.

2-Progressive Video Recording, most Machine Vision Cameras capture progressive video that can be RTD (Recorded To Disc) with a normal off the shelf PC. Progressive video is a must for a correct projection & PC display.

I have done tests and I find 30fps (frames per second) more pleasing when projected in a 60hz dual projector set-up because each frame is displayed twice and its better than 24fps because you don't need especial equipment or to render the video with a [3:2 Pulldown](#) for display at 60Hz or fps.

When 24fps was adopted for film recording, they also displayed (and still do in movie theaters) in film projectors at 48fps and thus, each frame being displayed twice. When they started transferring movies to TV the [Telecine](#) method with a 3:2 pulldown was introduced for display 24fps in the 60 fields per second display of TV's.

Also Film Producers found that shooting at 24fps they will save a lot of money in film stock in comparison to shoot at higher rates (especially for longer productions that require a great deal of film use) The only advantage of shooting at 24fps that I've seen, is that requires less light than 30fps (1/3 of a stop) and 60fps (1 full stop) but this benefit its shadowed by the kind of look that fast movements of people and objects have (even the own camera movements like panning & zooming).

I have read some discussions over 24fps vs. 30fps or 60fps and some people prefer the effect of "make believe" that 24fps has over the "video" look of 60fps. I find that 30fps it still has the "film" look and with the before mentioned qualities. This whole thing of which is better is a matter of preference and need in some cases like fast action or sports. We can have a whole discussion topic over this, but this particular subject is not the main goal of this one. The good thing of recording with MVC is that you can select any frame rate that you like or need.

3-RAW Video Recording, with MVC you can record in [RAW](#) mode that offers the maximum quality for post production adjustments of video. If you want to read more info about RAW & its benefits, click the link to the topic on top of this one titled "Problems of 3-D Video Recording with Camcorders"

MVC besides RAW recording mode, offer recording on [RGB](#) 8bit or [YUV](#) 4:2:2 color space (4:1:1 with some cameras also).

4-Global Shutter, with Pike cameras (including F-145 and F-210c). Global Shutter on the CCD means that every frame is captured complete in progressive mode. You can envision this as when you take a picture with your digital still photographic camera, you get complete frames.

With Roller shutter (CMOS sensors) you get motion artifacts that don't look right in moving images (video). There are some MVC manufacturers that offer less expensive HD 1080p "cinema" cameras, promising that they are good for producing movies, be cautious in believing all the promises that they'll tell you! Ask them for footage with those cameras.

Some professional (more expensive) sensors like the ones used on the SI-2K camera (AltaSens sensor) and the Red Camera (Mysterium sensor), being CMOS sensors, suffer from this problem also! Although they manage to "correct" the problem that rolling shutters have by shooting at twice the speed and dropping every other frame. Not matter what they say and do, I prefer a global shutter instead!

The only advantage that I see with the new crop of CMOS sensors is in the low noise department. The analog-to-digital conversion can be done directly on the chip, which theoretically, makes for a cleaner final signal with less digital noise. This is why digital still photographic cameras like the new Nikon's D300 and D3 offers low noise at high ISO's.

In CCD's sensors like the Kodak on the AVT Pike F-210c camera, can output a descent image with low noise if you set the right Gamma settings. I had set Gamma in the middle settings in the images that I shot in this thread:

http://www.davidrubio3d.com/view_topic.php?id=240&forum_id=68

(Edit: Off line now, but some of them are shown in the chapter "1080p Video Stills made with MVC's")

They look good to me!

5-Perfect Synchronization, can be achieved with MVC when recording with the appropriate software like StreamPix4 (SP4) although it still exist the problem of keeping a perfect rate (with variations of just a few frames) but this problem can be corrected with an external trigger for both cameras in conjunction with SP4.

6-Weight of Cameras, having 2 cameras perfectly aligned side by side it's not an easy task even with a tripod, and less weight means less hassle...If you have the "Transitions" 3-D DVD you can see in the "Making Transitions Featurette" the great problem of filming 3-D with the huge camera costing \$500,000 Dlls.(in 1986) and running 2000 ft. of 70mm. film every 3 minutes! no wonder almost anybody wanted to make 3-D productions before.

With MVC in a tiny body (in comparison) and with models with 1" CCD (yes you've read this right) for shooting 1080p HD Video at around \$5000 US Dlls. each (at present time), the rules of the whole game of 3-D production has changed! The largest sensor size found in any professional camcorder is 2/3" even the Sony Cinealta costing \$80,000 US Dlls. has this sensor size. There are MVC camera models for the consumer market in the \$780 US Dlls. range with a 1/3" sensor! (in the topic previously mentioned I explain why sensor size matters) Also the 1/2" models can be purchased from \$1000 US Dlls....try that in a professional camcorder costing (the less expensive) almost 5 times more!

I am not saying that IMAX (70mm film) will disappear, or even standard 35mm film (not yet), but everyday sensor (CCD & CMOS) design is improving and it's closing more the gap with film, that has that rich color saturation and above all, the widest [Dynamic Range](#) still available. The best digital sensor that I have seen approaching film is the one found in the DSLR's [Fujifilm Finepix S5 Pro](#) (and S3) camera, but I have too see a similar sensor in a MVC yet or camcorder for that matter.

7-Interchangable Lenses, even tough with professional camcorders you have this too, the lenses are prohibitive expensive for most people. On the other hand C-Mount Lenses are relatively cheap and with excellent quality for video.

8-Custom resolution and frame rates, with MVC's you can select any pixels resolution that you'd like depending on the sensor capabilities. You could select for example aspect ratios like:

- 16:9
- 1.85:1
- 2.40:1
- 2.76:1
- Etc.

Try that with any camcorder, including professional grade like the Sony Cinealta!

Also frame rates like 24p, 25p,30p or 60p* (*with select cameras) can be chosen.

Conclusion:

3-D Video Recording it's not as easy as grabbing a regular camcorder and press the record button, but 2-D is not near as good as 3-D...and for those who like the best and are willing to pay the price (in money & time learning how to do it right) MVC are the best bet....and you have this forum to share your experiences along the way! (Edit: offline as well, but can see some of it in the Internet [WayBack Machine](#)).

This is my 3-D “baby” (in its last recorder configuration), that I worked for so long and cost me many things (more than money can buy) on the way to complete...

I started doing the research on **September of 2006**, and as seen on these pictures I finalized it on **January of 2010**. It took me 40 months...(3 years and 4 months)

But the first 3-D “ready” single computer version, was finalized in **March of 2008** though. 18 months after I started my research.







- Two [AVT Pike F-210c](#) cameras (1" Kodak CCD).
- 1080/24p up to 30 fps progressive.
- Recording Uncompressed Raw and Cineform Raw.
- [Norpix-Streampix 5](#) DVR (Digital Video Recording) software.
- Fujinon C-Mount lenses 12.5mm, 25mm and 50mm.
- 22" Zalman Trimon 3-D monitor.
- M-Audio box and Sony headphones.
- [Jasper 18" Slide Bar](#) (modified for a 50mm Stereo Base).
- Four 256 GB removable 2.5 "laptop" Hard Drive Disks (with Solid State Disks recording capability too).







[Here](#) you can see these and more full size Tiff images.

Before you make a 3-D production, you have to test the camera IQ (Image Quality) first to make sure if it will “cut the cake” or not for your intended final 3-D delivery (Cinema or HDTV).

Here is my first 1080/24p video recorded with audio using a MVC (Machine Vision Camera) I made back in 2007.

The **AVT Pike F-210c** camera.

It's in the Cinema 2.40:1 aspect ratio.

I used **Cineform Raw** compression (6:1) on the fly, at 12 bit color depth.

It was recorded **December 14th of 2007** in our home in **Wisconsin**.



<http://www.youtube.com/watch?v=bilD9wogII8>

Here are my first two 3-D videos using my MVC's 3-D system.

I used Cineform Raw compression on the fly.

The first video was recording with one computer per camera, as seeing here in this picture:



Me recording my first 3-D video with MVC's



The first video is a 1080/24p Cineform Raw 12 bit.

The videos are side by side because Youtube 3-D did not existed back then in early 2008.

March 1st, 2008 in Cambridge Wisconsin USA.



<http://www.youtube.com/watch?v=w63kuB3IQvc>

The second video was using a single computer for both cameras:



Here the best helper I ever had, and I will ever have besides his brother **Alexander Rubio** (he was too little still to help us back then) the beautiful **David Rubio**!



This is a Cineform Raw 8 bit video.

March 24th, 2008 in **Lake Ripley** in Cambridge Wisconsin USA.



<http://www.youtube.com/watch?v=4DqJ2A5f5CM>

Here is another full resolution version:

<http://www.youtube.com/watch?v=xlrf2FumOgU>

It seems that the video is a little bit out of sync, maybe because I was doing Cineform Raw compression on the fly with a relatively slow Quad Core 2.4GHz computer or because the shutter speed (SS) was not identical in both cameras. Also I used a slow 1/24th SS instead of a better 1/48th one.

Also the audio is out of sync since I edited the video in a laptop that the audio does not work...sorry about that.

These are my two first Uncompressed Raw 1080/24p 8 bit 3-D videos, recorded with my MVC's 3-D system. Streampix did not offer audio recording back then, so I used Adobe Audition and then sync the video in post. But since Audition stopped recording in the middle of the first recording, in post I made a “voice-over” with Adobe's Soundbooth software.

The first video was recorded **July 13th, 2008** in **Fort Atkinson Wisconsin, USA**.



I need to re edit it and upload it again ...please look for it later on my [Youtube channel](#).

The second video was using telephoto lenses (50mm Nikon lenses in a 1" CCD sensor cameras) and you can see my beautiful and loved son, **David Rubio!**

1080/24p Video taken in **July 20th, 2008** in our home in **Wisconsin USA**. (sorry, the left video is slightly out of focus...I had come back from work and I was really tired!)



<http://www.youtube.com/watch?v=IU1DsSNKts8>

After I posted those two topics on my forum (www.davidrubio3d.com) and later on I included such images and some videos perfectly in sync for 3-D Cinema, they did not go unnoticed by the Cinema 3-D industry producers, and after two years since the “official” beginning of the project (December 2006) in December of 2008 it was “it”, a mayor Director and Producer, [Robert Zemeckis](#) “jumped on board” on the use of MVC's for his **Motion Capture 3-D** movies, I remember that I was celebrating with my wife our 7th Anniversary when I received the excellent notice, I couldn't have received a better “present” made by another person, other than the one my lovely wife **Heidi** gave me that night!...

Immediately after that (December 08-January 2009, [Josh Klatt](#) from New York city, also jumped on board in the use of such cameras for **Live Action 3-D** productions.

AFAIK, (according to info he gave me when we met on September of 2009 in Los Angeles CA.) [Brian Gardner](#) who was one of the first members on my forum and the Stereographer consultant on Coraline 3-D, he was the one that suggested the use of such cameras for that **Stop Motion 3-D** movie production.

But according to [Lenny Lipton](#)'s blog, in his [second post](#) (of September 2006), he was the one suggesting “Industrial Cameras” for that movie...

I have asked him a couple of times (in comments on that post) when was the decision made to use a MVC with a Kodak 4K sensor...but he just deletes my comments and ignores me. I wish he had done the same when I started his Wikipedia page in early 2007.

Nobody told me anything before my visit to LA, and I read the “news” myself in an American Society of Cinematographers magazine article of [February of 2009](#).

If I remember correctly Lipton is mentioned on the article, but what happened to Brian?...go figure!

Who is saying the truth and who is lying?

I don't really care, the only thing that I care is that MVC's work for 3-D Cinema! Yeah, I am not that crazy after all :-)

Please read the next 3 chapters for more info on each 3-D Cinema capture method, where MVC's are been used today.

A little bit more of history and up to date info regarding MVC's for Cinema applications...

After I proposed the use of MVC's for 3-D Cinema in late 2006, some time around 07' the [Silicon Imaging SI-2K Mini](#), started to be used for 3-D Cinema productions too. Many people still use them for that...

Other cameras targeted for 3-D Systems also come from this same concept, for example the [Cunima 1 & 2](#) that use the same [Altasens 2K CMOS](#) sensor than the SI-2K mini uses.

And also, when people all over the world saw that the images of the Kodak CCD sensors were not bad at all in 2007, other Cinema cameras systems begun as well.

First it was the [GS Vitec Nox 2K Cinema](#) camera that used the 2K version (1.5" CCD) of the [Kodak 1" 1080/30p CCD](#) that the [AVT Pike F-210c](#) cameras have, but it was kind of expensive at \$80,000 USD and it seems that they stopped producing it and selling it after awhile...

And later on in 2008 with the newly (by then) announced [Kodak 2/3" 1080/60p CCD](#) sensor...other camera projects started, like the [Sparta](#) camera from Spain (it hasn't been finished yet), the [Ikonoskop A-Cam DII](#) camera from

Sweden (just recently finished) and the [Drama](#) camera project from Greece.

And who finished a camera with that sensor before all of them? **AVT** with the [Prosilica GE-1910c](#) (1080/30p version) camera in late 2009! I tested one in early 2010.

The **IO Industries** [Flare 2K](#) camera, the [Modula BABY](#) that is actually a [Basler Ace 2K](#) camera, and the [Point Grey Gazelle 2K](#) camera, all of them are MVC's that use the same [CMOSIS 2/3" 2K/340p](#) CMOS sensor.

Also the new [Cunima NANO](#) has the same sensor.

I think all of those cameras can use the [IO Industries DVR Express Core](#) for recording 3-D (besides a "Studio" recorder).

And more recently, the just launched [SinaCAM 3-D System](#) that uses the Kodak 2/3" 1080/60p CCD too. AFAIK it only records up to 1080/30p with that little recorder, if you want 1080/60p you will need a larger one, maybe a "Studio" kind (computer based).



And also the recently announced [IndiePOV](#) that is a MVC too, but only does 1080/30p tops...

There is another new camera from that company, the [IndieGS2K](#) that has the previously mentioned CMOSIS 2K sensor and since it has a global shutter I prefer it more than the rolling shutter on the IndiePOV camera.



A [Christmas Carol](#) 3-D was the first [Motion Capture](#) 3-D movie that used Machine Vision Cameras (MVC's).

They started using MVC's for the movie in 2008, and released the movie in 2009.

Now the use of MVC's in this kind of 3-D movies is in worldwide use.

I don't know much about how those movies are made, I have read some articles and watched “behind the scenes” bonus material in DVD's, but in real life I've never seen a movie production using Motion Capture. But what I know though, is that the characteristics of MVC's are definitely almost “perfect” for such digital movie capture.

I don't even think that they use HD 1080p Bayer cameras for recordings, since they are using several cameras at a time, if I remember correctly they are in the “mega pixel” resolution range.

[Coraline](#) 3-D was the first [Stop Motion](#) 3-D Digital movie that was made with Machine Vision Cameras (MVC's).

They don't use two cameras for recording 3-D movies, instead they use the “cha-cha” method where they record the left side and the right side separately with the same camera.

A really time consuming and patient work since they record every frame at a time (I don't think they do complete 24 fps separately though, judging by the characters movement)...

They used a 4K resolution camera head (with an integrated cooling fan) for such movie, but I don't know what resolution they used for capture, since the sensor can be “windowed”...3K Bayer for 2K finish would do just fine.

What are the advantages of MVC's for 3-D (or even 2-D) in such movie productions?

AFAIK, with this digital capture they started using DSLR's ([Digital Single Lens Reflex](#)) cameras for such movies. Yes they offer Uncompressed Raw capture too, “check” on that part, but the problem is that the shutter life doesn't last very long (400,00 shutter actuations with top of the line current cameras)...

And for Stop Motion they need to take a **lot** of pictures, double for 3-D.

MVC's having an electronic “global shutter” (CCD's and some new CMOS), they last for millions and millions of “pictures” or grabs as they are more commonly known in that industry.

In the long run, a \$7,000 4K resolution MVC is cheaper than a DSLR costing less.

Also you can make the de-Bayer and export of the frame at time of capture too...don't need to re-open every Raw file in a photo editor for correction and export. That alone saves a lot of time in the workflow.

You can see some discussions and more info on this, in this thread on the Yahoo 3DTV group:

<http://movies.groups.yahoo.com/group/3dtv/message/19675>

[Josh Klatt](#) an extraordinary Stereographer and a dear friend of mine from [New York City](#), was the first one to produce Live Action 3-D movies with my Machine Vision Cameras 3-D system (MVC's 3-D) in early 2009.

He is a very intelligent man, and after several travels to “3-D houses” in Los Angeles, (I don't know of another person traveling so much from coast to coast doing research and “shopping” comparisons like him) I remember that he contacted me first for some questions via e-mail, and then told me that he would get back to me in the future...

It seems that after that extensively research, he made up his mind and finally contacted me by phone for his purchase order of the first MVC's Stereo 3-D system in history! And the only one I made besides mine unfortunately...

But that doesn't matter, the first sale is the **most** important in a company, that means that someone trusts you and the product you are selling!

It was a **mayor** success for me, after spending more than \$50K USD and some much work and effort, the first sale was finally coming!

He did not mind to carry a “bulky” computer for recordings, as he comes from a background where many Photographers use one of those on set for Digital Medium Format Photography capture (those Uncompressed Raw files are large...)

I also remember that he told me that “my system” was the cheapest in the world, in comparison to all he had seen back then (at around \$15K USD for a 1080/up to 30 fps 3-D system).

He mentioned that one day he would visit me on my yacht, because of some much money he thought I would be making in the future with this kind of 3-D system...well that is not going to happen in this life unfortunately.

I did not start this project wanting to be “rich” per say, I was already rich and blessed with my wife **Heidi** and our two beautiful sons **David and Alexander Rubio** (D&A Rubio).

I started it first because **I love 3-D**, and because there was only one very expensive HD 1080p 3-D camera system (valued at \$2 million) when I started it. Since I did not have the kind of resources for a “chance” of making it in the 3-D Cinema Industry back then, I had to work on my own 3-D system (all early 3D Digital Systems were a DIY -do it yourself- kind of thing too).

And also because this is what “I was born to do”, recording movie pictures almost like our own vision system sees them in real life, in 3-D!

...But that also might be the cause of my “death” as well...

But yes sure, who would not want to have his/her own yacht?

Maybe that will happen in the next life...maybe.

Here is Josh's web-site and some of the [3-D videos](#) he made with his system.

Things have changed significantly since I officially started this project in December of 2006, 5 years ago.

AFAIK, back then there were only two 3-D Cameras, [The Fusion](#) camera (made by [James Cameron](#) and [Vince Pace](#)) a 1080p camera system based on the Sony CineAlta f-950. And the [Panasonic DVX-100 3-D](#) camera system made by [Jason Goodman](#) of 21 Century 3-D from New York, a 480p Standard Definition camera that they claimed that it was outputting “720p”, because of the sensors shifting and Uncompressed RGB recording capability...

Now we have “dedicated” 3-D camcorders made by those 2-D camera manufacturers (Sony and Panasonic) and many others, both for the Professional and “consumer” market sectors.

Also since DSLR (Digital Single Lens Reflex) Photographic cameras, and other Digital Photographic cameras (like mirror less systems), started to include 720p and 1080p (heavily compressed de-Bayer in camera) video recordings capabilities, many people started to work trying to synchronize them for 3-D video. Just like they have been trying with consumer camcorders for years also...What are my thoughts on both approaches?

Please read the next two chapters for more info.

Do I like 3-D camcorders, would I use them?

Yes for the first. And maybe for the last.

List the **advantages** of them:

1-Perfect synchronization.

2-Matched zooming capabilities, and single adjustments for both left and right lenses.

3-Easy “gun and run” type of shooting, you don't need to align anything, just turn the camera on and start recording. If you are a desperate person or kind of lazy, this is your best bet...

4-Auto Focus, for certain persons and places of shooting this might be good, but for most Pro 3-D work I prefer to have Manual Focus (MF) control though...The Professional line of cameras always offer MF as well...that's why they are labeled Pro quality.

I like the way some 3-D Camcorders look, they're cool! (some of them remind me of “[Wall-E's](#)” head :-))

I probably would use some of the consumer level to record my little kids in 3-D with some limitations, but not for Professional paid work.

Disadvantages:

1-3-D camcorders have a fixed Stereo Base “SB” (or Inter Axial like some calls it), that limits your Stereo creativity a **lot**. Please see the “Stereo Rules” chapter for more info on this.

2-Although I like the use of smaller sensor sizes for a deeper DOF (Depth of Field), especially useful when using wide lens apertures like f1.4 in low light environments, a 1/4” or 1/3” sensor size packing 1080p resolution (or more in some cases) are plainly too small. At least a 2/3” sensor size is called for that kind of resolution.

Even the [Panasonic AG-3DP1](#) (58mm SB) 3-D camcorder, that is supposedly the current “top of the line” Professional 3-D Camcorder has 1/3” tiny sensors.

Smaller pixels mean lower light sensitivity and lens diffraction problems, see these websites:

<http://www.luminous-landscape.com/tutorials/understanding-series/u-diffraction.shtml>

<http://www.cambridgeincolour.com/tutorials/diffraction-photography.htm>

The [Sony PMW-TD300](#) has 1/2" sensors but the recording codec is only 35 Mbps...50 Mbps is the minimum most TV broadcasters accept today.

3-Most consumer grade 3-D camcorders (read: cheap), compress the 2 side images into 960x540 pxs resolution in a side by side 1080 video format.

4-Highly compressed recording video codec. There is not such thing like “lossless” compression for video.

The 3DP1 can record with the AVC Intra 100 codec, which I think is the bare minimum with decent quality for up to 1080/24p recordings. For Broadcast work that might be “acceptable”.

A workaround for the in camera compression is to use external recorders that can record ProRes or Avid DNxHD at 220 mbps. Such bit rate is 6:1 compression when recording 1080/24p. As you increase the frame rate the compression will increase.

Uncompressed RGB 444 recordings are also possible with some external recorders.

What about 3-D cameras like the [Fuji W3](#) or [Sony Bloggie 3-D](#)? Besides having a fixed SB as well, they are 3-D Photography cameras with added 3-D Video capabilities...they are in the category of Photo/Video cameras, read the next chapter for more details on those.

But if you don't want to read that, I will tell you right here what it is. Besides the extreme compression and reduced resolution in both views like some consumer 3-D Camcorders do, the video recorded with such cameras has bad aliasing problems due to the “line skipping” read out of the photo sensor while recording video. Especially noticeable in wide angle shots, with small objects in the scene.

The only advantage of them is the same of 3-D camcorders, they have perfect sync, auto focus and matched zooming capabilities in the case of the W3.

But these 3-D cameras offer an added advantage that 3-D camcorders do not...they are really small and can be carried in your pocket at all times. Nobody will notice you are carrying one of those until you take it out for recordings....and even then most people would not notice that is “3-D”, just a regular point and shoot camera. This might be good for certain places.

And what about price? They are really cheap!

So for consumer use they are “ok”...

There are a lot of discussions all over the web about how to perfectly synchronize 2 DSLR or other Photo/Video cameras for 3-D work...

Many people are working in this difficult issue.

Even if they find a “cure” for that, the number one disadvantage for me is the need of a Beam Splitter rig (or Mirror Rig) for 3-D video. Just by this single reason, they are a “no go” for me.

I have two DSLR's side by side for 3-D Photography (Sony A-300's), but they are in the “portrait” or vertical FOV (Field of View). This reduces the Stereo Base (SB), but still having it fixed it limits my Stereo Photography creativity a lot.

And the use of a Beam Splitter, is besides the most problematic issues when recording video in most of those cameras, that are:

1-Extreme Aliasing and Moiré (due to the line skipping read of the sensor).

A 18 MP+ sensor for 1080p/i resolution output? (like 3 times less horizontal resolution). Come on guys from what “planet” you come from? :-) Bayer sensors are already problematic “guessing” missing pixel information as they are...now imagine increasing the problem 3 times.

2- Skew from the rolling shutter in most CMOS (there are already CMOS with global shutters but AFAIK, none of the current DSLR's have them yet).

3-Extreme video compression.

4-Depth of Field for 3-D (read the “DOF & 3-D” chapter for more info) most DSLR's are in the S35mm format, even if you choose a 4/3” format like the Panasonic's mirror less camera systems, the light sensitivity will suffer a lot by the reduced size of pixels in the sensor. You can increase the ISO sensitivity for this problem, but in doing so you will increase the noise as well. And also you will need a more powerful resolving lens for such tinny pixels...and those lenses are not cheap!

And my question is this:

Why try to reinvent the wheel???

MVC's (Machine Vision Cameras) already offer everything these people want for 3-D, and more:

-Perfect synchronization

-Uncompressed Raw recording

-2/3" sensor size for a deeper DOF, especially useful in low light with wide open lens apertures like f1,4.

-Side by side stereo configuration down to 33mm Stereo Base.

-Price, now with 2K cameras starting at \$1500 USD. I don't see a reason for a "shortcut" with other systems...

-Small Uncompressed Raw recorders

-Up to 340 fps for cool Slow-mo 3-D!

-Better display for focusing and preview of cameras alignment with a laptop monitor, having both displays side by side on the screen. And 3-D pre visualization with stereo viewers like [these](#): (I like the **Pokescope**)

What else do you want or need???

The only thing is that MVC's wont make the coffee for you in the morning, sorry...;-)

If you don't want to make it yourself go to Starbucks instead, they serve delicious coffee there and you'll have a good time listening to music and have “free” internet access too.

First things first, in order for you to understand the whole concept better, you must learn these simple Stereoscopic Rules:

Ortho Stereo:

Ortho Stereo refers to a normal view of things like we see them with our own eyes.

The SB must be (approximately for an adult eyes separation) 2.5" (inches) or 6.5 centimeters, which is the same as 65mm (millimeters), for easier use all Stereo Base (SB) measurements are in mm.

Hypo Stereo:

Hypo Stereo is not the same as Hyper Stereo, and actually is the opposite, scenes and objects appear to grow larger and is use to make appear normal objects or people like if they were bigger or giants. Other use for hypo stereo is to be able to record insects or tiny objects (macro stereo work).

For 3-D Photography of inanimate objects and scenes usually 1 camera is used on a slide bar, changing positions for the second picture to be taken. For 3-D video, if the cameras are small enough to permit a side by side shooting it would be ok, if not, then a Beam Splitter rig must be used.

One of the 3-D movies that amazed me, was the IMAX movie [Bugs 3-D](#), where they were able to film tiny insects in Stereo. That was never been done before, and it was a breakthrough achievement by a team led by [Peter Parks](#).

Hyper Stereo:

Hyper Stereo derivates from the Greek prefix "hyper" that means above or beyond, and in 3-D use is achieved by increasing the SB to make distant objects or scenes appear with sufficient depth. In order to calculate the correct SB you have to take into account the 1/30th Rule according to the Focal Length (FL) lenses used, to have a proper 3-D effect.

In 3-D photography this can be achieved with a single camera and successive exposures (for inanimate objects or scenes), or with 2 cameras (spaced some distance apart) and fired simultaneously.

There are 2 ways of interpreting a hyper Stereo picture or video, one is to think of the observer as a giant looking at a smaller world. The other way is to think of the scene as a shrink model of the real scene.

1/30th Rule: this is the "Golden Rule" for Stereo Photography.

The 1/30th Rule refers to that the Stereo Base (SB) or "Interaxial" separation between lenses (from center to center) should be no more than 1/30th the distance of the **Nearest Point "NP"** (subject/object) to the camera lenses (not necessary the main).

This 1/30th Rule causes a separation of each stereo side (sometimes called **NetD "Net Deviation"**) to be 3.3% ($1/30=0.033$)

This difference between the two stereo sides is also called "disparity" by some Stereographers.

This NetD is favored by [Roger Maddy](#) an American great Stereographer and a friend of mine. We both are known to be "crazy" in the 3-D world, but as Mr. Jobs said once, I see genius in him...sometimes when he is not joking around :-)

Example:

For a Normal Stereo Effect (Ortho Stereo) the SB is of 2.5" or 6.5cm (65mm). You multiply 65x30 and that gives you 1950 mm (millimeters) or 1.95 m (meters).

So your NP, has to be at least 1.95 m away from the 3-D camera lenses.

Now, in **real world use** how can I apply such rules?

It would be great if we could use Ortho Stereo (65mm SB) with a 35mm FL in FF 35mm photography terms all the time just close to Stereo Realist film camera used, but it's impractical for all kind of shootings, so we have to change FL's lenses for full length, mid body and close up shots, and maybe the SB to get closer to our NP...

This 1/30th Rule is good for watching Stereo 3-D in any viewer or projection stsytem since it offers 3.33% NetD, like with "side by side" Stereo viewers like the [Stereoscope](#) or [View-Master](#), and with computer displays viewers like the [Pokescope](#) and other similar [Stereo viewers](#).

For video there are headset Stereo 3-D viewers, like the new [Sony HMZT1](#) where each video side is viewed only by each eye, so there is no "ghosting" or "**crossed talk**"...just pure beautiful immersive 3-D! Just the way I like it baby!

But if we increase or decrease the Focal Length (FL) of the recording camera lenses we have to adjust the SB as well to keep the 3.3% NetD.

The 1/30th Rule is good for a 35mm FL in 35mm FF (Full Frame) terms, and when the Furthest Point (FP) on the scene is at infinity like in outdoors. There are some good and free Stereo Calculators like the [BaseCalc](#) or the [Anaglyph Stereo Capture Calculator](#). The [StereoBrain](#) is also good but is not free.

The BaseCalc is my favorite for its simplicity. For the MAOFD (maximum allowed of frame deviation) use this formula. If the sensor width is lets say 11.2mm (in a 2K sensor with 5.5 micron pixel size), divide that between 30 (3.3% NetD). $11.2/30=0.37\text{mm}$.

A simple formula (**mine**) that I use to calculate the SB when the FP is at infinity, is this one:

Since a 35mm FL is 1/30th, then lets say I use a 28mm FL lens. I divide $28/35=0.8$ then $\times 30$ (1/30th Rule)=24. So that's my Rule to use for such FL. A 1/24th Rule.

When the FP is not at infinity, use the Stereo calculator instead since the SB is wider.

For a 85mm lens it would be like this: $85/35 \times 30 = 72.8$ or 1/72.8th Rule.

Just divide those numbers from the NP and it will give you the SB. For example if your NP with the 85mm lens is at 2.5m use this. $2.5/72.8=0.34$ or 34mm SB.

[Here](#) is a lengthy discussion about such NetD Stereo Rules and other formulas around, read it to see what good you can get from it. The 3DTV Yahoo group has one of the best "think tanks" in the 3-D community, since is one of the oldest around (more than 10 years online, but the group has people who have been doing 3-D for decades).

Ok, let's do some examples for Cinema applications with **my** formula.

If you want to take a picture in the horizontal perspective (landscape) with full body of people (full length) with a wide angle lens (28mm in FF 35mm), you need to be approximately at 2.7 m away (9 feet approximately). But FF

35mm has a 1.5:1 aspect ratio. Digital Cinema ratio is **1.89:1**. That means than now you have to step back 1.26 times more, or at 3.4 m away approximately.

For this very issue I don't recommend wider aspect ratios like 2:4:1 for 3-D Cinema, because you will need to step back even more for the full length shots...and causing a more pronounced "Hyper Stereo" effect doing so...

3.4 m is our target for our **full length** shots.

So 3.4 m away with a 28mm lens, that means that our cameras SB must be $(28/35 \times 30 = 24)$ now $3.4/24 = 0.141$ or a 141mm SB.

In order to get closer than 3.4 m we would have to use a wider lens but that would objects and subjects in the background to look more distorted than when using a 28mm lens.

Actually a 28mm does that a little bit too, but its still acceptable. A 35mm is what is called a good wide angle without distorting things so much, that's why the **Stereo Realist** camera used close to such FL (between 35-42mm). Now the **Fuji W3** starts at 35mm FL too.

But if using those, then instead of 3.4 m we would have to step back for our full length shots to 4.2-5.1 m, and our SB must be 140mm and 141mm respectively. Which at the end is the same SB, but in many interiors you don't have such space to work from.

Sometimes in small interiors you don't have a choice but to use really wide angle lenses...like a 20mm or 24mm lenses to be able to be as close as 2.4 or 2.9 m with a 140mm and 141mm SB respectively. If needing these FL's for full length shots, be extremely careful with perspective...and if you can, just avoid those kind of shots.

Now what to do with the mid body shots? You have two choices, stay in the same distance (3.4m) and double the lens FL to 56mm (from 28mm) which is considered as a "normal" lens, or get closer to half that distance (1.7 m) without having to change lenses.

But getting mid body shots with a wide angle lens causes more distortions in the background, so I would say that a more balanced perspective would be to use an in "the middle" FL of 28mm and 56mm instead. A 42mm FL.

Let's see some comparisons: (some are approximations as possible)

Wide Angle (31mm in FF 35mm)

1" DOF, f1.4 aperture, ISO 160, 1/24th Shutter Speed (SS). 24 fps. Fujinon 1" 12.5mm C-mount lens. AVT Pike F-210c camera (1080/30p Kodak 1" CCD)



Normal lens. (63mm in FF 35mm)

Same as above, around f5.6-8 aperture (with polarizer filter), Fujinon 25mm C-mount lens.



2/3" DOF, f1.4 lens aperture, ISO 240 1/30th SS. 30 fps. 12.5mm Fujinon 1" C-mount lens. AVT/Prosilica GE-1910c camera (1080/30p Kodak 2/3" CCD)



Same as above.



Which FL you prefer?

Isn't it true that the first wide angle shot of 31mm, even in these 2-D video grabs, seems more “three dimensional” by itself than the next “normal” shot of 63mm?

The interior house background has limited depth, but still beats the normal lens shot that even though has more depth in the background, it still seems more “flat” in comparison.

And even in the inside shot my body is slightly bigger in size in comparison to the outside one, and I don't look too much “distorted” do I? (well I am not a “model” of beauty per say, but still...:-)) But the background does a little...

But the two 42mm FL shots are more “balanced” than the previous two aren't they?

So this FL is the “keeper”, our target as a “normal” lens for mid body shots.

So instead of being 3.4 m away with a 56mm lens and a 70mm SB, with the 42mm lens we can work from a more comfortable distance of 2.6 m ($3.4/2 \times 1.5 = 2.55$) and with a 72mm SB ($42/35 \times 30 = 36$ then $2.6/36 = 0.072$ or 72mm)

What about the Close up shots?

Again, we could get to half the distance with that FL, use a double FL lens from the same distance, or go in the “middle” between the two.

If we go in the middle for this kind of shots, we would need a 63mm FL ($42 \times 1.5 = 63$) and it kinds of "pushes" the limit for close ups since it will distort people faces a bit. So I think for close ups I would prefer to double the FL instead to 84mm.

Why not longer FL's than that? Because that FL is almost "perfect" since it does not cause too much distortions nor flattens the subjects, nor the background with the subject as a longer telephoto does. This FL was my favorite for Portrait Photography, even more than a 105mm FL that it was the so called “standard” for such work. Do an internet research on the subject if you want to, and you'll be surprised!

The 85mm Nikon MF AI-S lenses are a beauty “well hidden”. But they won't be much now that I opened my mouth right? :-)) Don't matter; they can produce more of those if the demand is there.

I don't have shots to show you of a similar FL that I made with MVC's, but here are a couple of 85mm FL shots I took with a [Nikon D700](#) DSLR. They have an extremely out of focus background because I used an f2 lens aperture in FF 35mm format. But still they don't see very much flattened do they? Look at my beautiful son David's body, it looks “three dimensional” even in this 2-D photo isn't it?

Then compare below those two pictures, a couple of video grabs that were shot with a 126mm FL.



1" DOF, f1.2, 1/24th SS. 24 fps. ISO 160. Nikon 50mm lens (with C-mount adapter). AVT F-210c cam.



1" Fujinon 50 mm lens, f5.6-f8 lens aperture, the rest same as above.



See how me and David seem more “flat”, and also the background is “compressed” or flattened against us and out of focus on these 126mm FL shots? That’s what you get such FL's...even in that moderate telephoto range you can see those things easily, now imagine a 300mm or longer FL's...those cause “card-boarding” or “cut-out” effects in 3-D...not very pleasing, that’s why I don't think that 3-D is well suitable for sports or concerts and those kind of events that you can not get close to the action...

The out of focus in close ups, is still acceptable in 3-D since we may want to “isolate” our subject and don't want the viewer to wander in the background...but we don't want to flatten our 3-D effect do we? If we wanted that, then what is the point of 3-D? Shoot 2-D instead and you'll be better off!

So using a 84mm FL we can be at the same distance at 2.6 m and use a 36mm SB ($84/35 \times 30 = 72$ then $2.6/72 = 0.036$)

But If you don't have even that distance in interiors, you can use the in between FL of 63mm lens for moderate close ups. And get close to 2 m ($2.60/2 \times 1.5 = 1.95$) with a 37mm SB ($63/35 \times 30 = 54$ then $2/54 = 0.037$)

That and all previous mentioned SB's are easily achievable with a side by side camera configuration using really small camera heads. Read the "Cinema 2K Bayer" chapter to find out which cameras can do that!

Choices, choices, life it's full of them isn't it? And that's the way it should be, otherwise if we only had black and white what fun should it be after a while?

Make your own tests to decide what way you want to go...at least with these explanation I made you think didn't I?

Please read first the [Parallel](#) and [Convergence](#) definitions.

This is probably the most controversial subject of Stereo work. There are many experts with different opinions about it, there is a lot of info on the web about this. Read it besides this and make your own conclusions.

Some point out that our eyes converge on objects/subjects (from now on I will call both as "objects") all the time, especially for really close range objects.

And yes is true, our eyes **need** to do that because we can not change the Inter-Ocular distance for those kind of shots correct?

But with Stereo cameras we can do it, we can change the "Inter-Ocular" distance (sometimes is called that, but it's wrong since only applies to our vision, does "Ocular" rings a bell here?).

In Stereo cameras the right name is Inter-Axial, but since I am "old school":-) I prefer to call it Stereo Base (SB).

Ok, so with separate camera heads (or full camera bodies in a Beam Splitter rig) we can change the SB as we please. A thing that is impossible with our eyes.

And when watching Stereo 3-D in a flat screen from a distance, for the most part we don't need to use convergence with our eyes isn't it true?

Only maybe when watching 3-D in a really close distance, like in laptop displays or smaller.

But even there, if the stereo was shot with a proper SB with parallel placement of heads/cameras we see a better 3D than if it was shot with convergence. Why?

Because converging cameras while recording stereo, causes [keystone distortions](#) in the background. Our eyes are extremely well designed (by an explosion, and then an "evolution" system? Yeah right!) and can "work out" those distortions by getting the background out of focus.

And that's what people who swear by convergence copy too. But the problem with that approach while recording stereo, is that once the background is blurred you can not get it back to "normal" again (not yet, but [Light Field Photography](#) seems very promising in that regard). While our eyes can instantly change, where to **focus** in a scene.

That is freedom my friends! We were created to have freedom of choice all the time.

So we have to offer the viewer the same freedom too...how? Having the greatest depth of field in focus as much as possible, especially for wide angle "busy" scenes. Close ups might be acceptable with limited depth and focus (read the next "DOF & 3-D" chapter for more details on this).

So what then?

For me, and to speed up things while shooting stereo, I prefer parallel placement of the camera heads rather than to set the "point of convergence" adjustments, or "toe-in" in cameras every time.

You can set your horizontal Parallax values in post doing an Horizontal Image Translation (HIT), to get proper "out of screen" (Negative Parallax) or "inside the screen" (Positive Parallax) Stereo effects.

Which one do I prefer? I little bit of Negative Parallax or out of screen effect looks very good! Don't over do it though, just a little bit is ok. If you set your point of convergence at time of recording, you get keystone background distortions that are time consuming and difficult to correct in post.

This chapter is very important also for your indoor lights needed equipment.

This is another controversial subject in 3-D work as well (like convergence vs parallel shooting), there are some people who prefer one or the other, but I would say that a more “balanced” approach is needed here.

Read this and at the end make your own conclusions about the matter.

For the most part, especially in “busy” scenes like wide angle shots where there are many things to see and “scan” in a scene, in 2-D or 3-D is more desirable to get the most possible in focus. Regardless if you agree with this or not, is a reality with wide angle lenses, even at moderate wide open apertures (like f2.8 in a S35mm format size).

But Regardless of that too, I know that some still won't agree with me o this, but just think the way our vision system works for a little bit. When we look at a scene we have the choice to focus our vision everywhere we want isn't that true?

Is also true that when we look at close distance objects the background gets out of focus, but still we have the choice to instantly “scan” other objects on the scene...even the background gets in focus right away. [Light Field Photography](#) wants to replicate this, where you have the choice to focus almost every where you want, foreground or background.

Eventually this technology will be the best to record images because is in part how our own vision system works, but given the information that needs to be recorded, where even small pictures require an extraordinary amount of space, this technology at this point is too futuristic for video, even for SD 480/24p resolution.

So for some time yet, we have to select focus when recording our scenes, the most we can to give the viewer the freedom to scan all scenes as much as they want to. It's relatively “easy” to do that with wide angle shots in outside natural lighting, but it gets more difficult to achieve it with inside artificial lighting, especially if we don't want to use powerful lights (that for the most part use a lot of energy, get hot and are unconformable for people. There have been improvements in some lighting systems for the two first issues, but they are not cheap for the most part...)

I haven't done a lot of research on lighting systems yet, so you have to do that yourself and decide what you like and can afford.

For me indoor available lighting is the way to go, because is very difficult to light a scene for 3-D, and available light by itself it gives a “3-D effect” already even in 2-D photography (that is why I prefer it than the use of flash the “flattens” the scenes and in some cases cause a “dark cave” effect where the main subject is well lit while the background its dark). Also going this way, you don't need a lot of “Cinema” lights...those were made for film rated ISO/ASA 500 tops (yes I know, you can “push” the rating more than that...but it introduces more grain or “noice”...thing that I don't even like in 2-D less in 3-D!)

So instead of relying on lights or gain for extra “sensitivity” we need to focus on the sensor instead...with today sensor technology we can get a relatively clean ISO 640 (at 0dB). That's great because in 3-D noise is not acceptable because it looks like mosquitoes flying all over...and out of sync! Yikes.

Now working with such sensor sensitivity rating lets get to work into what we would need for most available indoor lighting we will encounter in most places.

Note about this:

Gamma settings affect the rated sensitivity of sensors, depending on the curve used, so this applies with a “middle” gamma setting. Is preferable to record with such gamma curve and then manipulate it in post anyways.

Also all brand lenses even though are rated “equal” as in the same lens aperture, they are not perfectly matched, so you have to do your own test with the lenses you have in mind buying.

In my previous tests I found out that with such “available” indoor lighting, it ranges between these 3 options: All at 1/48th Shutter Speed (when using 24 fps or 48 fps).

DOF comparison first: An **f1.4** lens aperture in a **2/3”** 2K sensor size (11.2mm wide with 5.5 um pixel size, all the comparisons are with the same pixel size) would be similar in DOF to **f2** in a **4/3”** 3K sensor, and to **f2.8** in a **S35mm 4K** sensor.

2K-2/3”: f1.4 aperture

ISO 320, 640 and 1280

3K-4/3”: f2 aperture

ISO 640, 1280 and 2560

4K-S35mm: f2.8 aperture

ISO 1280, 2560 and 5120

Which lens aperture you think is more manageable with a ISO 640 rating?

2/3” f1.4 wins! That's why I prefer that sensor size for 3-D work. At least the middle setting in such is what I want for ISO rating in a sensor at 0dB gain. ISO 640 is what some new CMOS sensors offer, like the [CMOSIS 2K](#). Great! One day though, I want ISO 1280 for 0dB...

For less sensitivity ratings with such high number, I can always use ND (Neutral Density) filters. Or gain minus ratings like -6dB, -12dB and -18 dB (with CMOS). In an extreme case, not recommended for all work though, we can increase the Shutter Speed (SS) to reduce sensitivity without the previous two.

You can still work with 4/3” and S35mm sensor sizes at f2 and f2.8 apertures respectively no problem, but good bye “available light” and 0dB gain. Choose what is best for you, more lights, more gain or more lens aperture, for me is a “no brainier” and I prefer the latest...but not less than those ratings because the DOF would be extremely narrow. That's not too good for wide angle shots.

And those are in a side by side camera configuration, put the cameras in a Beam Splitter rig and you will need in the best case scenario 1 1/2 f-stops more of light or sensor sensitivity! Yikes.

Even with such lens aperture ratings, I would prefer a deeper DOF than those though, but most wide angle shots are with sufficient DOF at those apertures, especially in indoor environments when you don't have much depth anyways. The problem are the close up shots, but in those we might want to focus the viewer in that particular subject/object, so an out of focus background in 3-D here is complete acceptable for those kind of shots don't you think?

This way we have a win-win situation too!

As sensor technology advances and we can get a higher “clean” base ISO/ASA sensitivity at 0dB gain, than ISO 640 then we could probably use smaller lens apertures in a 2/3” sensor size, like f2 or f2.8. Like I said before, we could still use those now, but we have to increase the lights that will be extremely uncomfortable for subjects or up the ISO/gain....and “gain” means loss in something...in this case we lose clean images and get noisier ones.

Ok this is a debatable subject even in the 2-D world, more in the 3-D one!

What is my take on the matter? I like both.

Primes for indoors and outdoors when you have time to change them, and maybe Zoom for outdoors when you don't have much time to be changing prime lenses.

Why?

Primes:

I prefer prime lenses for indoors because there are some that have f1.4 aperture and some of them (especially useful for the mid-telephoto) are 33mm wide.

Also they cost less and have less optical distortions than zooms.

Zooms:

They are especially useful in situations where you don't have much time to be changing prime lenses. Like in live events or when time is limited and changes rapidly, like in sun rise or sun sets.

Also having a zoom lens in outdoors is very good, because you don't have to worry of dust getting on your prime lenses while changing them. And the maximum f2.8 aperture of such lenses is a non issue outdoors.

But you can not use them for close ups without a Beams Splitter rig since they are not narrow enough for a side by side camera placement.

First "p" means [Progressive](#) frames, not [interlaced](#) nor other gimmicks that some cameras use to send "progressive" frames over interlaced infrastructures. Progressive capture and recording is the real deal.

There is a lot of controversy about this issue regarding 3-D Cinema too. Most experts on the field agree that is time to "move on" to higher frame rates for 3-D.

I like higher frame rates for 3-D too, actually [I was one of the first](#) to propose this for 3-D Digital progressive capture/projection back in 2006...if not the very first.

My first tests with a [Basler A601fc](#) camera in September/October of 2006 (the first MVC that I ever used) was comparing 24p,30p and 60p. Then in January/February of 2009 I also made and posted comparison tests on my forum about 48p vs 60p made with an [AVT Marlin F-033c](#) camera.

48 fps or 60 fps?

I personally like **60p** better because movement is smoother, even when you do fast pans (not recommended for 3-D though).

Is like a window to reality and with an **Uncompressed Raw** and **3-D** capture combination is like you really transport through time watching those scenes! Human beings have always dream with a [Time Travel Machine](#). Well 3-D 60p Uncompressed is the closest you can do for recording present events, that later on you can "travel back" too. I don't think is possible to go beyond this experience...only in dreams maybe?

Most Digital Cinema and home projectors can handle at least **120 Hz** and that is good for 60 fps footage.

Besides that almost "religious experience", and landing into harsh reality...film projection is still 24 fps. Bluray is 24p,25p and 30p at full 1080p resolution.

Also 3-D HDTV calls for a delivery of 1080/25-30p or 720/50-60p, Although I like the higher frames of the latest better, making comparison tests I found out that 720p footage displayed in a 1080p screen, it looks kind of soft in comparison with native 1080p video. So here 1080/25p-30p wins too.

But the advantage of 720p for 3-D with current bandwidth infrastructures is to send the two full side videos in a 1080/24-30p pipeline, instead of sending one full 1080p side and one side with only "the difference" in the scene. AFAIK, both left and right views are completely different! So here **720/24-30p** wins also. And in 3-D the perceived resolution.

So I prefer 720p 3-D for home viewing, since is good enough resolution when watched from normal sitting distances.

From 60p you can down convert easily into all the rest of those frame rates, but going from 48p into 50 and 60p you have to "invent" information that it was not recorded in the first place, but at this point in time, think if the increased workflow requirements of 60 p or 48 fps vs 24 fps is worth the "hassle" if you'll end up doing that anyways...

Also having into account current equipment bandwidth speeds, for a **2K** Bayer Uncompressed Raw 8 bit capture I could use up to **60p**, but for a **3K** Bayer Uncompressed Raw 8 bit to 2K finish, I don't have a choice but to record **48p** with a single portable [DVR Express Core](#) recorder (see the "Media speed and file sizes" chapter for more details on this). I can do **4K/24p** tops with a single recorder.

So at this point we have to consider that film 24 fps projection is still well alive and not going anywhere anytime soon, and maybe we want our movie to be shown in 2-D as well.

Also the new [Technicolor 3-D](#) film projection over/under system, is appearing in Cinemas for its low cost vs digital projection. It is 24 fps too.

After your movie has run its “life” in the 3-D Cinemas (if even makes it there in the first place)...sometimes that happens in two weeks or less...If you shot higher frame rates you might have to “down-convert” the footage to lower frames rates again...

Most people don't care if 48 or 60 fps “looks better for 3-D or not”, most of them wont even notice the difference, and some of them who do (Cinephiles) might even complain that the footage looks like the afternoon news or has a “[soap opera](#)” look...you can't make every one happy, can you?

Just make yourself a favor, make yourself happy first and if the world doesn't like it so be it, as long as you are...and that also applies if you choose 48 fps or even 60 fps.

In conclusion: It's a complicated issue that doesn't have a definitive answer; I suggest you do your own calculations and possibly some comparison tests too to decide what is best for you...and can afford in the workflow.

In the summer of 2003 when I bought my first Digital Photography camera ([Olympus Camedia 5050](#)) I noticed that it had three modes for recording pictures. [JPEG](#), [TIFF](#) and [Raw](#).

First I made a comparison test between Jpeg vs Tiff, and since I saw “no difference” other than the Tiff files were gigantic in comparison to the smaller Jpegs, and also were slow to be written to the card, I chose Jpeg.

I also tried the Raw mode but since they needed extra “manipulation” and conversion, and were also slow to be written to the card, I “settled” for Jpeg with that camera.

And since I bought that camera not for professional use anyways, just for personal photography and to “learn” digital capture, Jpeg was just fine at the time.

So I did not work with Raw files much...Then I bought a book of “[Digital Photography for dummies](#)” I was one of those back then...:-) Then I found out that both Jpeg and Tiff were “baked in” formats, after you took your picture it was little to be done to try to correct the shots in post...(though the Tiffs were easier to manipulate in this regard because contained far more information than the Jpegs).

Then I tried it Raw again, wow that was it! I had found a “film” negative comparison! But I still continued to shoot Jpegs with that camera as I already explained why...and I had to wait until the summer of 2004 when I bought the [Nikon D70](#) DSLR camera to start shooting everything in Raw, after that I never looked back again! (well I still shot Raw+Jpeg small sometimes)

It seems that even for camera manufacturers those early models were a “test” as well...since after that most of them removed the direct Tiff shooting mode and only left Jpeg and Raw (Prosumer and Professional models).

With FF 35mm film scans saved to Uncompressed Tiff 8 and 16 bit that I made with a [Minolta Dimage III scanner](#), (which I think it has a Bayer sensor, hence only resolves true 4:2:2 color) I did not see any “visible” difference either... You can do those kind of test for yourself if you want to.

Also another good idea is to do your own comparison tests with a Professional DSLR still camera to see if Uncompressed 12 or 14 bit is worth the “hassle” for you or not. For the higher bits set the cameras for 100% Uncompressed Raw pictures. Then use compression if possible that matches 8 bit (1:5 compression from 12 bit).

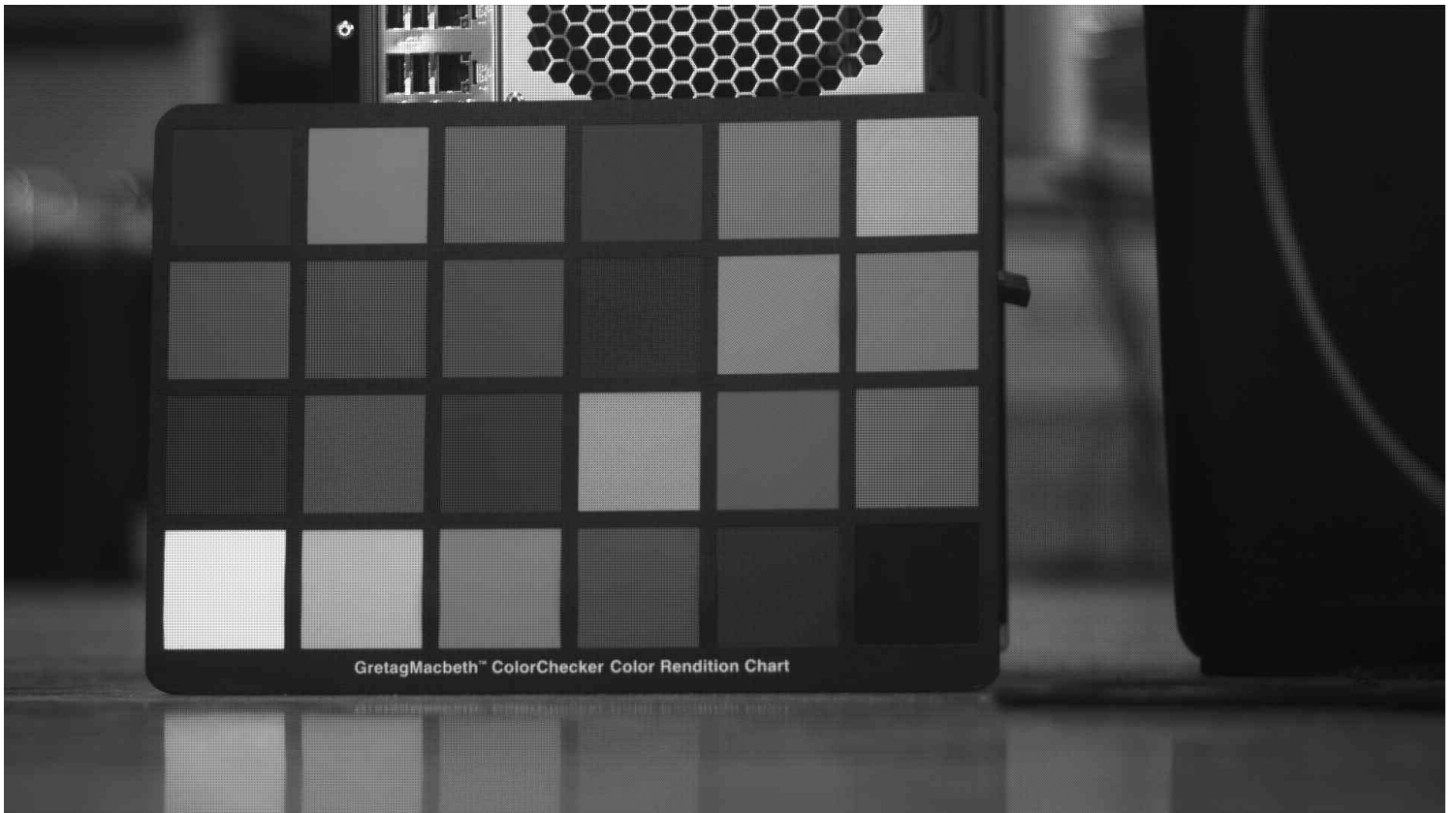
Here is a test I made with MVC's. These original files were Uncompressed Raw 8 bit, and 14 bit (recorded over Raw-16). Hence they are Grayscale or B&W, and I saved them directly to Uncompressed Tiffs 8 and 16 bit files respectively.

You wont be able to “play” with them since this document compressed them, but they'll give you an idea of what I am talking about...(I hope). Both were converted to PNG files to be able to import them in this book.

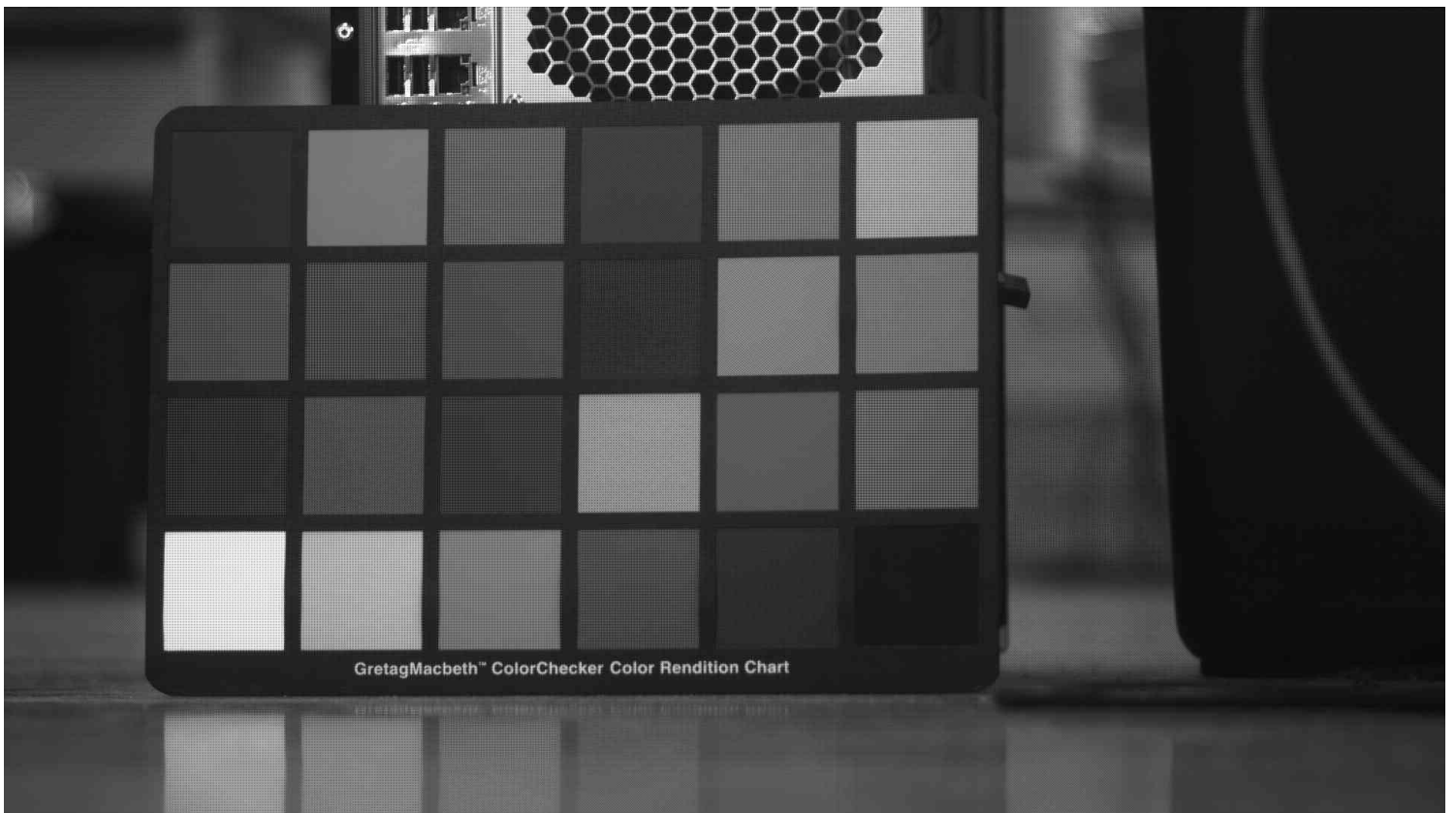
But [here](#) are the originals files in full resolution, the 16 bit was saved as PNG.

Single [Bayer](#) sensors can not output true 4:4:4 color (12 bit), only 3 sensor cameras can do that, like the [JAI 3 CCD](#) cameras. At best Bayer sensors can only output 4:2:2 (true 8 bit), hence you can not tell the difference in image quality of Bayer sensor camera at 8 bit vs 12 bit or even 14 bit recordings.

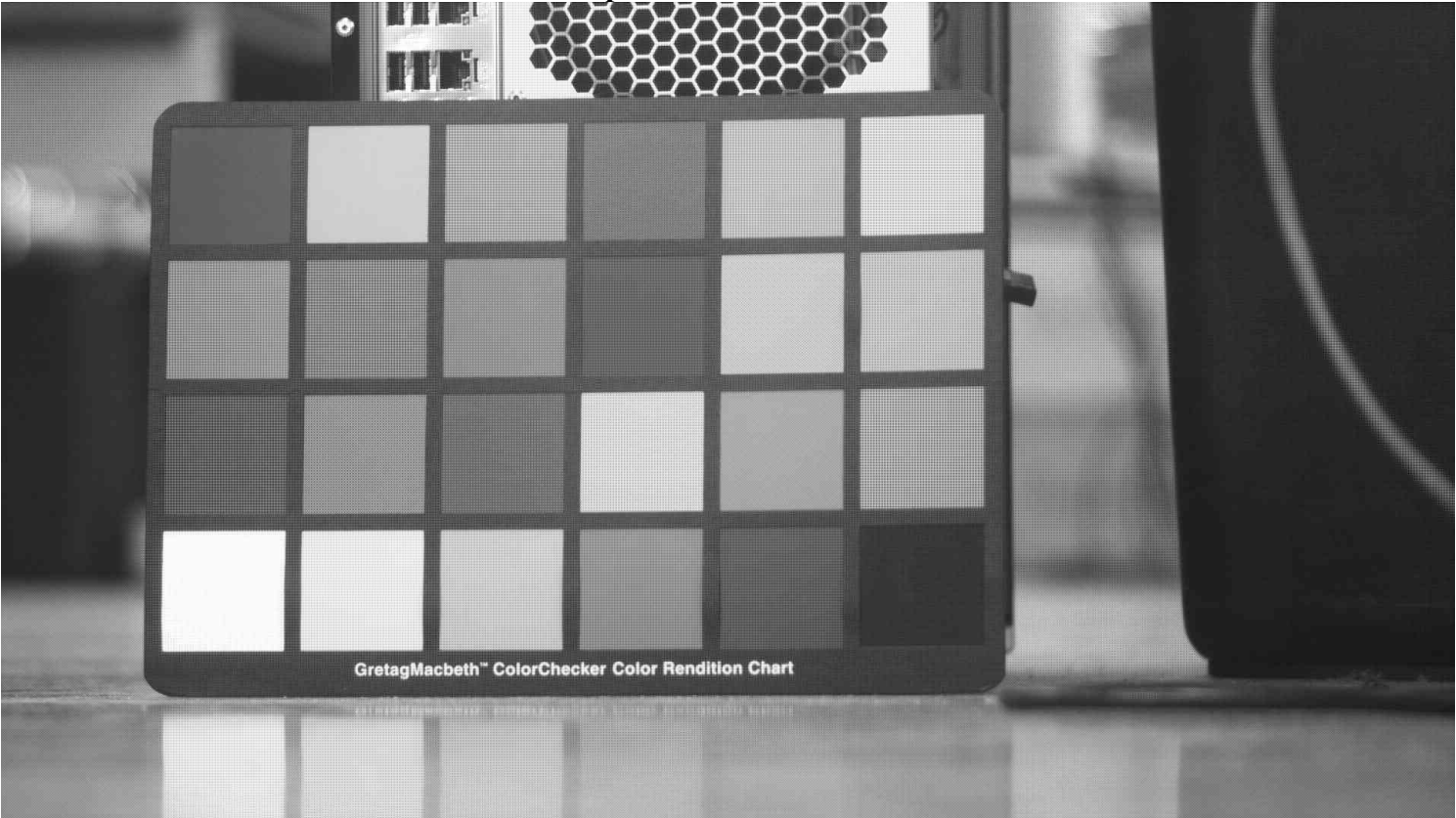
Sorry but this is the truth with single Bayer sensors, but the imagine quality of Uncompressed RGB video at 8 bit is still quite good! There is no need of 12 bit IMO.



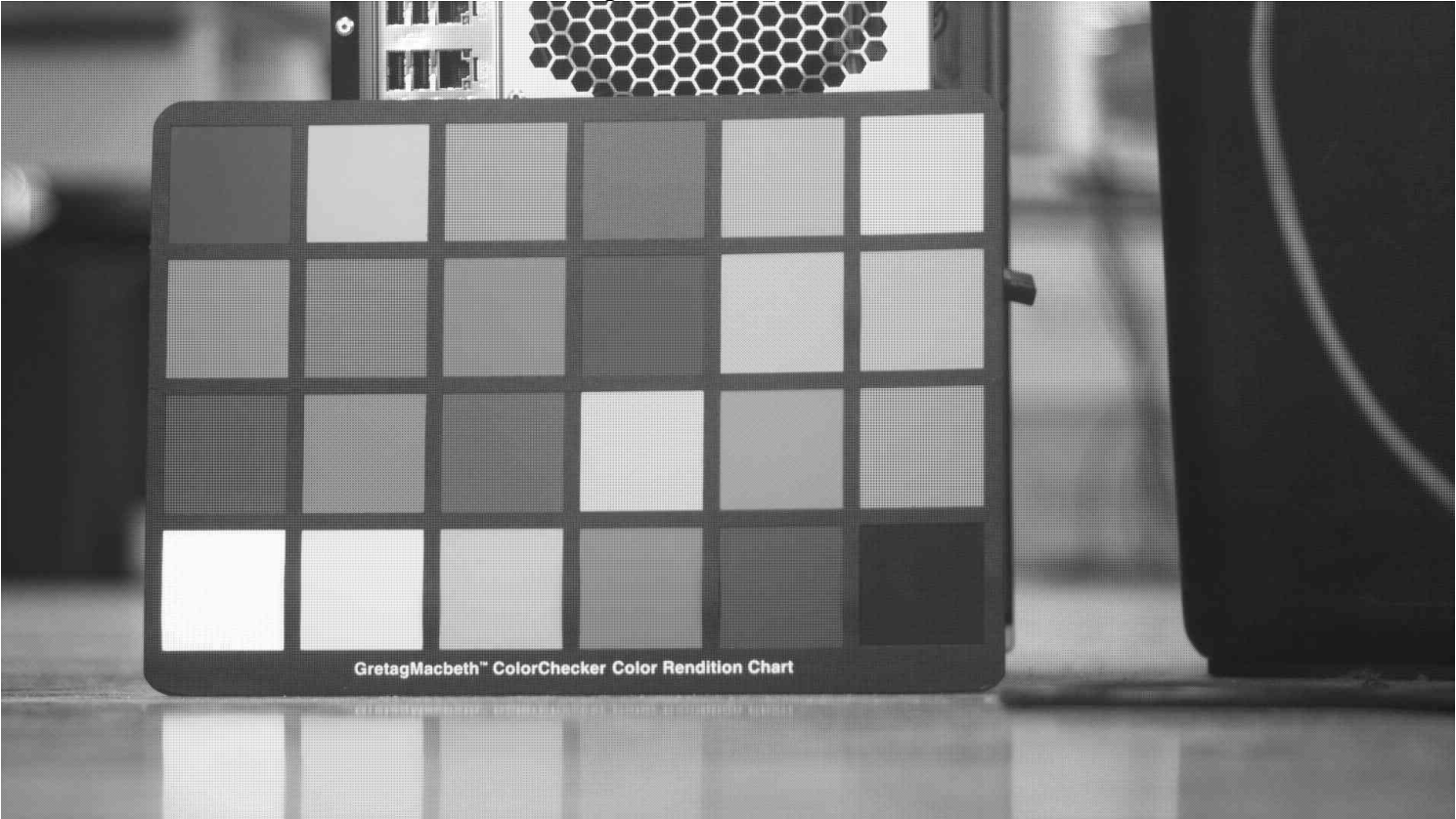
Uncompressed Raw 14 bit

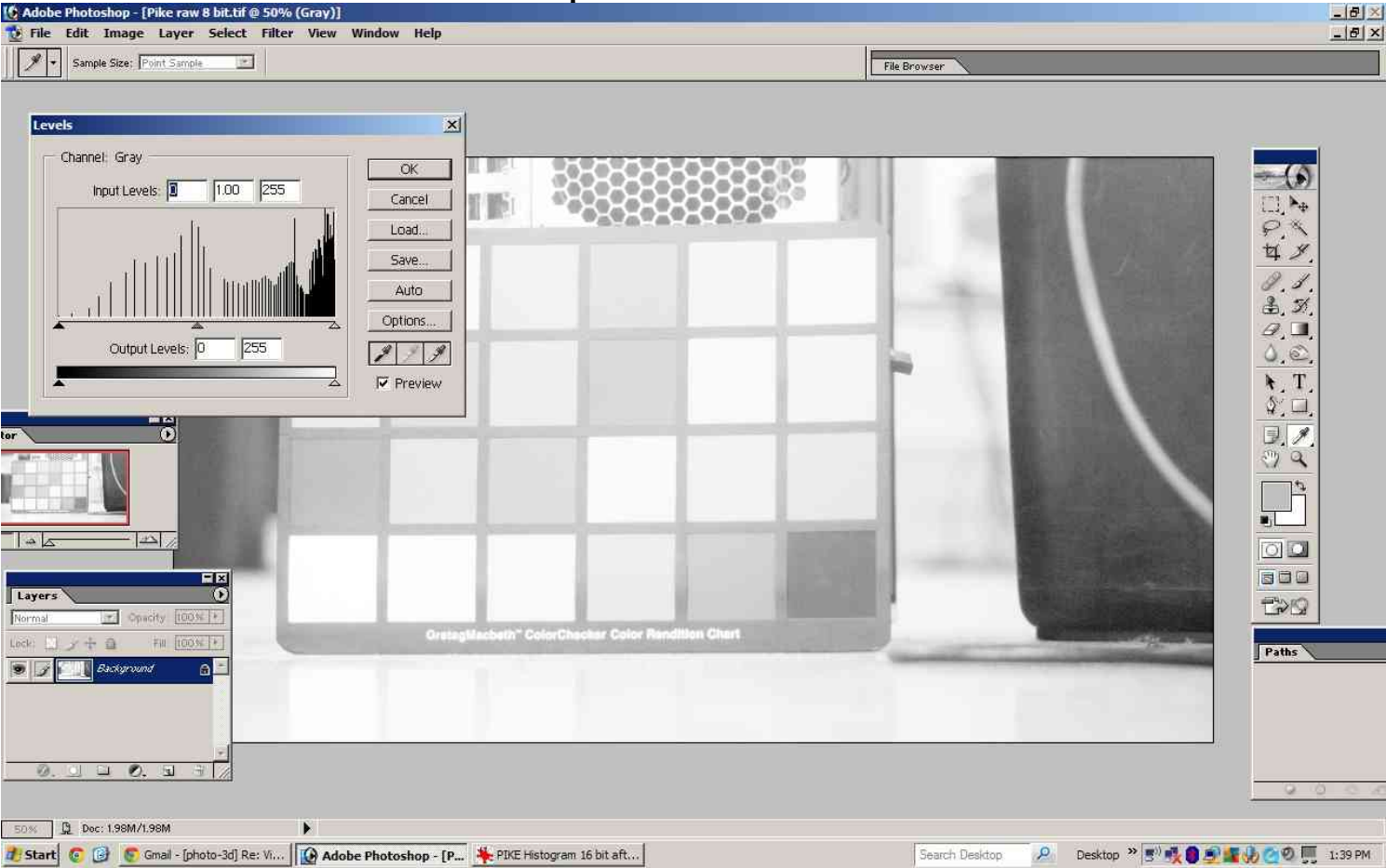


Uncompressed Raw 8 bit

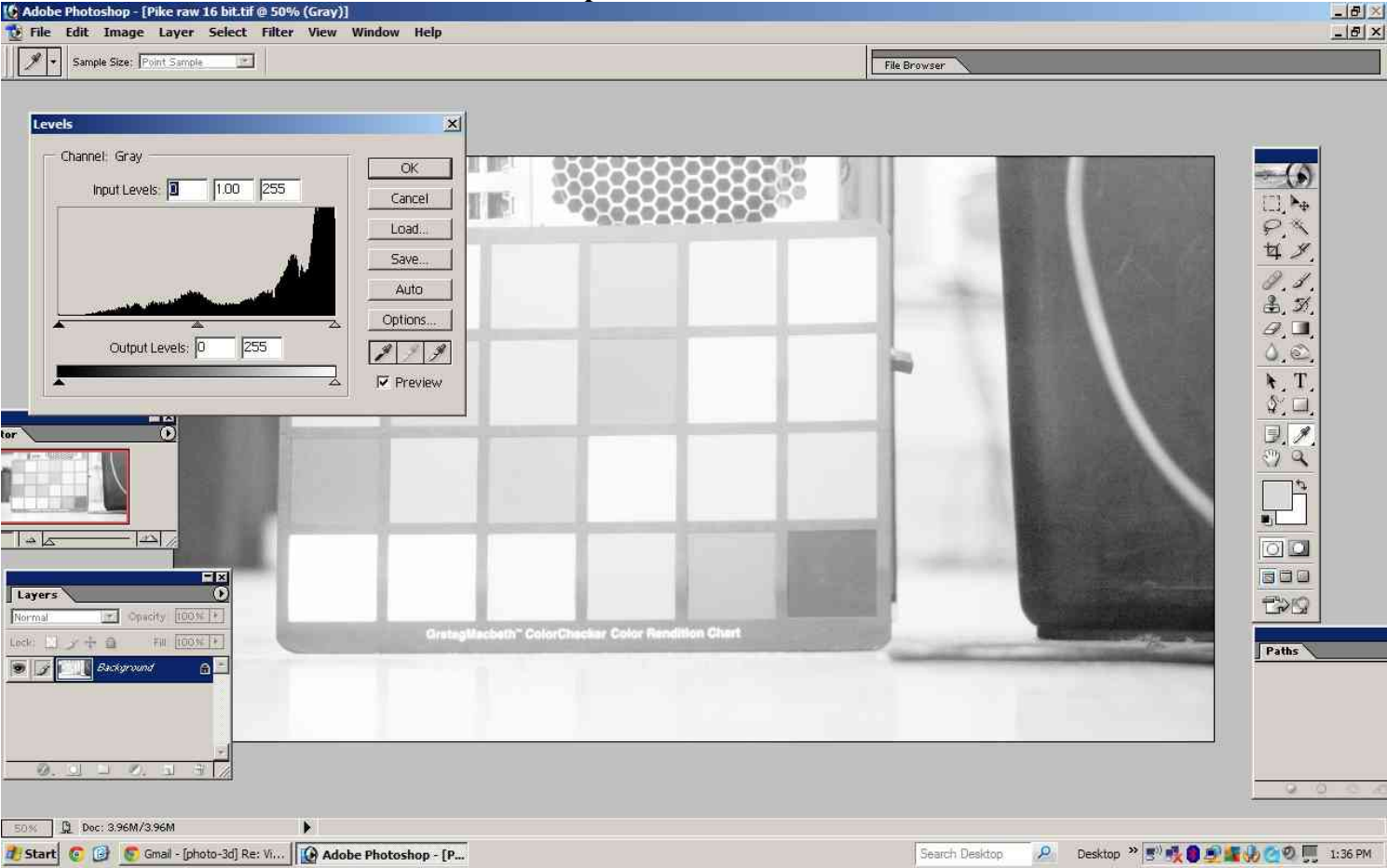


Uncompressed Raw 14 bit





Uncompressed Raw 14 bit



This last file says “16 bit” because I named it like that originally, because it was recorded over Raw-16 bit and saved as Uncompressed Tiff 16 bit. But it's just 14 bit.

Even in the originals is hard to tell the difference in these pushed tests. Maybe because most consumer displays are 8 bit anyways?...or because our eyes have a hard time resolving more than 8 bits (I've got this assumption from the Wikipedia page about [Colour Banding](#))

For the most part, the only visible difference that I can see is in the Levels info window...

Is the visual difference 75% better in the 14 bit over the 8 bit file? The file size it's bigger in that percentage at least...(or 100% if recorded over Raw 16)

So like I said before, do your own tests to see if it is better for you to record Uncompressed Raw 8, 12 or even 16 bit...and can deal with the increased demanding workflows.

For me at present time Uncompressed Raw 8 is the way to go...

Compressed Raw:

Before discussing this, here are 2 comparison tests. They speak for themselves better than words do.

They all are grabs from an 1080/30p Uncompressed Raw 8 bit video made with the [AVT/Prosilica GE-1910c](#) camera (2/3" Kodak CCD) f1.4 aperture I think, with a cheap Pentax TV lens.

I de-Bayered the video to Uncompressed RGB, Cineform HD Film Scan 2 4:4:4 (with Prospect 4K, now replaced by [Cineform Studio Premium](#)).

[Here](#) are the originals Tiffs resized to 720p.

Uncompressed RGB





Which one do YOU like better?

Me, do I need to say it? **Uncompressed RGB** just by looking at the still frames (Jpegs), also when you play the video in the Cineform HD FS2 4:4:4 video you will see added noise or better said a "mimic" of film grain...noise that is not present as much in the Uncompressed RGB version (you don't have to be very "picky" to notice that right away...)

And when you start pushing the files for color correction, since the Uncompressed RGB video has more color information, it will permit more tweaking without falling apart like the Cineform file do much faster.

But those Uncompressed RGB files are triple in size than the Uncompressed Raw ones, so a trade off will be to work with Cineform FS2 4:4:4 files instead since they are 1/4 the size of the Uncompressed RGB ones or 75% the size of the original Uncompressed Raw files. The quality of Cineform is very good for that compression ratio.

Update: 2-29-2012 David Newman from Cineform told me that the noise is a problem with the demosaicing algorithm chosen, so you have to make your own tests on this issue...what ever it is, I still think that Cineform FilmScan 2 is the best compressed video quality second to Uncompressed RGB.

Update 3-29-2012: And now exporting to Cineform Raw FS3 and Cineform Raw **Uncompressed** is possible with Streampix 5...they are still working with the Cineform Raw Uncompressed setting. Extra Note: David told me that he won't pursue this issue anymore since he does not see an added quality on Cineform Raw Uncompressed.

The quality of Cineform Raw leaves too much to be desired. These are the compression ratios over the original Uncompressd Raw files: Cineform Raw FS2: 6:1 and Cineform Raw FS3: 4:1

FS3 since has less compression offers a little better quality, but still not enough for heavy grading like in this underexposed footage.

See these examples when I pushed the files. All come from the same original Uncompressed Raw sequence.

Original Uncompressed RGB



Cineform HD Film Scan 2 4:4:4



Cineform Raw Film Scan 2



Crop



See the horrible compression on my sweater? It's not so bad on the HD FS2 4:4:4 file, and it makes sense since CF Raw FS2 is 4.6 times smaller than the HD FS2 4:4:4 file.

You can see the full resolution TIFF files including the Cineform Raw FS3 file, [here](#).

Now the blah,blah,blah...:-)

I have had some discussions on the [3DTV Yahoo Group](#) about this issue...and I am tired of discussions, they are time consuming and at the end most of the time both parties won't change their POV anyways...

I've read about "lossless" compression and some pointed out to Zip files...they might be right in those, but dealing with huge large video files is not that simple. And even with codecs like [Huffyuv](#) and others like that if you want the best quality, they are really slow compressing video. The best compression quality, the slower they become...same to "decompress" the video I think.

So at this time they are impractical for Real Time (RT) in camera compression. So for the time being there is no "lossless" real time video compression. Period.

Such thing doesn't exist yet even with decent not RT speed, you are throwing information, and no matter what you do later, you will never recover it.

You can lie to yourself and to others giving lengthy explanations in how a particular codec is "lossless"...but I trust mathematics more than any other explanation, they never lie. After all, the digital world is pure "numbers" isn't it?

So what is better then? It depends in the compression used and the bit depth (resolution has nothing to do with this as it applies to any resolution, whether is 2K,3K,4K etc).

Let's do some mathematical examples. But this only apply if you record Uncompressed RGB 4:4:4 (12 bit) with a camera that has 3 sensors, like the [JAI 3 CCD](#) cameras. Bayer sensors can only resolve 4:2:2 color at best (8 bit).

I will not go beyond 12 bit now because there is only one video camera (Sony F65) that even though it claims to record Raw 16 bit, I think is either Uncompressed 12 bit or Compressed 16 bit (1.5:1 ratio) ...mathematically speaking they are the same quality at the end.

MVC's can do 1080p 14 bit since 2006 or even earlier than that year....just like some Professional DSLR's taking Raw pictures. Believe it or not, both are more "advanced" in this regard than camcorders and even most Cinema cameras!

But since 14 bit has to be "carried" out by Raw 16 for the most part, the slight gain in quality is not worth it for me for the extra bandwidth and storage space needed.

So I am going to set Uncompressed Raw 12 bit as the "king of the hill" for now. But as you saw in previous tests, unless you have a true 12 bit display you won't really see any significant visual difference with 12 bit over 8 bit...I won't go beyond 6:1 compression ratios because IMO for Cinema work is not acceptable (6:1 is the compression Cineform Raw gives approximately).

Uncompressed RGB 12 bit 100% IQ (Image Quality) information.

Capture:

Uncompressed Raw 8 bit: 67 % IQ and size

3:1 Compressed RGB 12 bit: 33% IQ and size

6:1 Compressed RGB 12 bit: 16% IQ and size

So clearly by these numbers, Uncompressed Raw 8 bit will beat in IQ information 12 bit 3:1 and 6:1 Compressed

RGB. By 100% and 200% respectively.

But in the other hand the compressed files will be smaller.

But lets not look things so simplistic regarding IQ information...especially if you are going to compress your Uncompressed Raw 8 bit video to 4:1 "12 bit"* Compressed RGB (Red, Green, Blue color) in post, like when using Cineform Film Scan 2 4:4:4 de-Bayering.

*Cineform FS 2 4:4:4 will "upgrade" you 8 bit footage to 12 bit supposedly, but is just the "envelope" that is increased, since the IQ information still comes from the original 8 bit (4:2:2).

Post:

3:1 Compressed RGB 12 bit: 33% IQ and size

Uncompressed Raw 8 bit with 4:1 RGB compression: 17 % IQ.

The numbers are a little "reversed" here, and the final files will be comparable to 6:1 Compressed RGB 12 bit.

Then what is the advantage of recording Uncompressed Raw if we are going to compress anyways?

A better slow de-Bayering process in post, rather that a "real time" fast one in camera/recorder.

And also like I said before, with Uncompressed Raw capture you are securing your work to be "future proof", for a possible later "re-mastering"...(if you cannot deal with an Uncompressed RGB workflow right now)

But if you don't think that something like that will happen (never say never) and don't want to bother with the workflow at this time, then compress on the fly, Cineform Raw FS2 will give you around 6:1 compression approximately...or better yet with Cineform Raw FS3 with only 4:1 compression.

For me, like I've mentioned also before, Uncompressed Raw 8 bit capture and de-bayering to Cineform FS2 4:4:4 is the way to go for the best compressed quality.

But the right answer for a 100% Uncompressed Raw workflow is the native implementation read of Raw files in a video editor, but that although is an "easy" task, it involves more that the software code work to do so in a NLE's...most of the time is based in the user base of such particular Raw codec.

And since "this thing" is just a "new born" kind of thing with just a handful of users still, I don't see that happen in a long time...hopefully I am wrong on this and it wont take too long. And also I hope that someone starts a "revolution" on this very important issue.

We'll see which 3-D NLE "jumps on board" first? [Sony Vegas](#), v12, 13 maybe...? That would make me really happy since its HQ are in [Madison Wisconsin](#)! Do you hear me buddies? We are "home town" buddies, yeah! :-)

Or maybe [Edius v6.5](#), since I like it very much for Stereoscopic editing.

Another supported workflow is to record directly to Adobe [CinemaDNG](#).

But at this point it seems that you also must de-Bayer the CinemaDNG files to other video codecs to be able to work with them (like to Cineform codec) and this would be the same as a direct de-Bayer the native Raw files to Uncompressed RGB or any other compressed codec like Cineform FS2, Edius HQX, ProRes etc...

This comparison applies at time of recordings for [Bayer](#) sensor cameras, and is not the same as Uncompressed Raw to Uncompressed RGB de-Bayering in post.

Just by the information on the "2K Cinema Bayer/ Editing Computer" chapter, this is a no go for me...(triple much bandwidth speed needed over Raw).

But there is more than that reason...read on.

I think in terms of pixel sensitivity Raw beats RGB output a little bit. Sorry I don't have any cameras to do tests right now to compare them, and when I had them although I recorded Uncompressed RGB and Uncompressed Raw (with the [AVT Marlin F-033c](#) camera) I did not make a side by side comparison for this...So I've got this assumption by an article written in the [Adimec blog](#) not too long ago.

But what I do remember just by looking at footage (without even making comparison tests), is that with a good (slow) de-Bayering in post, Uncompressed Raw gives a better IQ (Image Quality) than a real time de-Bayering in camera like direct Uncompressed RGB recording offers...

Besides those two things, the advantage of Raw is that you can manipulate it a little bit more in post if you don't have time to do those corrections while shooting.

And since the bandwidth of Uncompressed Raw is 1/3th of Uncompressed RGB, it permits also to record higher frame rates.

With Camera Link Base interface recorders, you can record easily Uncompressed Raw 2K/60p, while only 2K/30p Uncompressed RGB is possible.

Like I said, just because of that and a better quality slow de-Bayering process I prefer **Uncompressed Raw**.

For cameras with 3 sensors like the [JAI 3 CCD](#) cameras, recording Uncompressed RGB has definitely its benefits as they can resolve **true** 12 bit color (4:4:4 color).

These file sizes and bandwidths is what [Streampix 5](#) Raw files are approximately, other native Uncompressed Raw files from other camera and recording software companies should be similar too.

24p Uncompressed Raw

8 bit 12 bit

1080p Resolution (1920 x 1080 pxs)

Media writing speed: (Megabytes *)	50 MB/s	75 MB/s
File size: (Gigabytes)	2.8 GB/min	4.2 GB/min

*Do not confuse this with [Megabits](#) that are 8 times more than Megabytes.

2K Resolution (2048 x 1080 pxs)

Media writing speed: (Megabytes)	54 MB/s	80 MB/s
File size: (Gigabytes)	3 GB/min	4.5 GB/min

3K Resolution (3072 x 1620 pxs)

Media writing speed: (Megabytes)	120 MB/s	180 MB/s
File size: (Gigabytes)	6.75 GB/min	10.12 GB/min

4K Resolution (4096 x 2160 pxs)

Media writing speed:	213 MB/s
File size: (Gigabytes)	12 GB/min

25p Uncompressed Raw

8 bit 12 bit

1080p Resolution (1920 x 1080 pxs)

Media writing speed: (Megabytes)	52 MB/s	78 MB/s
File size: (Gigabytes)	2.9 GB/min	4.2 GB/min

30p Uncompressed Raw

8 bit

12 bit

1080p Resolution (1920 x 1080 pxs)

Media writing speed: (Megabytes)	63 MB/s	94 MB/s
File size: (Gigabytes)	3.5 GB/min	5.25 GB/min

48p Uncompressed Raw

8 bit

12 bit

2K Resolution (2048 x 1080 pxs)

Media writing speed: (Megabytes)	107 MB/s	160 MB/s
File size: (Gigabytes)	6 GB/min	9 GB/min

3K Resolution (3072 x 1620 pxs)

Media writing speed: (Megabytes)	239 MB/s
File size: (Gigabytes)	13.5 GB/min

60p Uncompressed Raw

8 bit

12 bit

2K Resolution (2048 x 1080 pxs)

SSD writing speed: (Megabytes)	133 MB/s	200 MB/s
File size: (Gigabytes)	7.5 GB/min	11.25 GB/min

I did not mention beyond **240 MB/s** bandwidths because that is the maximum that [Camera Link Dual Base](#) can do, do your own calculations if you want to find out about other combinations of resolution/frame rate and bit depths with different bandwidth interfaces. And that is using a single portable recorder like the DVR Express Core.

If you use one for each camera you can record up to 720MB/s with each recorder with Camera Link Full plus.

This is how you do it:

Multiply the resolution x for the desired frame rate x 1 for 8 bit (12 bit is 1.5 times, 16 bit is 2 times)

Example $4096 \times 2160 \times 60 \times 1 = 530,841,600$ or 530 MB/s.

Also I did not go beyond 12 bit either because AFAIK, there are non video cameras that can output beyond that Uncompressed yet. The Sony F65 in my calculations is either outputting 12 bit Uncompressed Raw or 16 bit with 1.5:1 compression; mathematically speaking they are the same in quality and size.

Some MVC's can already do 14 bit output, but for the most part is carried out in a Raw 16 bit “envelope” file...you increase the bandwidth and file sizes significantly from 12 bit...just for a 2 bit “gain” IMO, is not worth it.

What to use of all those choices?

Frame Rates:

For me at this time (and for the **Indie 3-D** producers), **24 fps**.

Resolution:

For me, **3K** for a clean 2K finish. With also 2K cameras resolution for the close ups ,(given their small size). I pass on 4K unless is a project for IMAX 3-D.

Bit depth:

For me, **8 bit**.

See the chapter “Uncompressed vs Compressed” for more details and consider the extra added workflow requirements of 12 bit vs 8 bit (1.5 time more bandwidth and storage space needed). 16 bit is double of 8 bit.

Resolution: 2048 x 1080 pxs. (pixels).

If you are reading this, is mostly because you don't have the budget for higher resolution cameras/equipment (but not necessary true 100%, especially if you read the "DOF for 3-D" chapter and like 60p for 3-D)

Probably you will be catalogued as "Indie" (independent) 3-D movie maker. It's ok don't worry, most famous directors and movie producers started this way...some of them are the exception to the rule as they started with the "right foot" on the biz, meaning that some one "backed" them up financially for their first project/s. For me is better to start from the "bottom/up", because all the knowledge you acquire "suffering" a bit, will be very useful even if you make it "BIG" one day.

Ok lets get started now, what do I mean by 2K Cinema Bayer? that is the capture resolution, but not necessarily a "clean" 2K finish.

2K Bayer resolution is not the greatest for a 2K Cinema finish, in order to get that you would need at least (2.25 times more total) or 1.5 times more horizontal and vertical resolution.

But doubling the frame rate to 48p or a little bit more with 60p, you increase the perceived resolution a little bit too, and you might be just fine!

For 2-D 24 fps Cinema I would recommend at least 3K Bayer for a "clean" 2K finish, but at this point and having into account the 5.5um pixel size, that would "jump" everything to the 4/3" (18mm wide approximately) sensor size and lenses...good bye 2/3" DOF!

You can still work side by side with the 4/3" format for the full length and mid length shots, but for the close up shots I recommend the 2/3" format instead.

2K/24p Bayer I would rate it to be close to S16mm film stock (even a little bit higher than that, and close to true 720/24p resolution), people are making award winning movies with that film size. And also a 2-D movie shot with the [SI-2K Mini](#) (2K/24p Bayer resolution) camera won an Oscar for best picture! [Slumdog Millionaire](#) (I personally did not like the combination of resolution-compression-gain used in some indoor shots, but I liked the story very much, and that is what it counts in the end)

But wait, before you stop reading here and jump to 3K and 4K Bayer, here are two advantages of 2K/24p mono and Bayer resolution for 3-D Cinema:

If shooting a 2-D B&W movie then 2K/24p mono resolution is perfect for a 2K delivery (and true **mono** cameras doesn't need an OLPF I think...they are not the same as camera heads with sensor that have a Bayer filter on top, that can do mono as well) .

For Color movies, 2K/24p Bayer to 2K finish is acceptable also if the movie is going to be shown in "3-D only" (like [U2-3D](#)), because the "overlapped" stereo projection increases the perceived resolution.

Think about all that to make your final decision in what route to take...2K 60p/48p, 2K/24p B&W, or 2K/24p Color "3-D only" version.

Like I said at the beginning, If you are still working with this format in Bayer cameras, it means that you don't have the budget for 3K/4K Bayer cameras and workflow...

So if you don't have that kind of money for gear that is relatively "cheap" in a production, where most of the costs are in actors and other things in the production chain...your production will be catalogued as "Indie" (Independent).

And your chances of showing your movie in “normal” 3-D Cinema chains are really small giving the number of 3D screens today, and that more 3-D movies with huge budgets are being released every year...many times fighting against each other for “prime time” in 3-D Cinemas.

GIANT vs GIANT...and you are small in comparison. But if you think you are “David vs Goliath” read below...

As always, there would be exceptions to this “rule” of huge budgets beating the crap out of small ones, as some movies with relatively tiny or small budgets were successful at the Cinemas too (relatively to their budgets), two that come to my mind are “[My date with Drew](#)” and “[Open Water](#)”...but those were 2-D productions.

So maybe your final 3-D production delivery only would be (for the time being), Bluray 3-D and possibly 3-D HDTV...and for the 2-D version, just “straight to DVD” (or Bluray). 1080/24,25 or 30p are fine for that.

Even though this 2K Bayer workflow has clearly disadvantages in terms of resolution over 3K Bayer and 4K Bayer, it has other advantages that those 2 don't have (with current Bayer sensor designs), like the use of the 2/3” format and DOF (I've talked about this in the “DOF & 3-D” chapter).

Also the Uncompressed Raw workflow is lighter than with larger resolutions. See the chapter about “Uncompressed Raw media speed and file sizes” for more details.

So after considering the DOF format issue, file sizes and resolution and higher frame rates, now let's go to the equipment and workflow you would need for this particular Cinema 2K Bayer rating.

This is the most portable you can go for now, expect improvements (smaller sizes) in the future at least on the recorder.

Camera Heads:

There are many MVC's with different HD/2K sensors out there; you have three choices with the 2/3" format size. A [Kodak 1080/60p](#) (1920 x 1080 pxs) CCD, a [CMOSIS 2K/340p](#) (2048 x 1080 pxs) CMOS sensor, and a new Sony CCD sensor (ICX674) that can do 1920 x 1080 pxs at 48 fps.

All have "global shutter", great especially for 3-D Cinema capture!

Supposedly the CMOSIS CMOS has better sensitivity rated as ISO/ASA 640 at 0db, while the Kodak CCD is like ISO/ASA 240. I wish I could make comparisons of both to compare noise at 0dB...but I don't think it will be possible now given my difficult circumstances.

If both have the same clean images at 0dB, then the CMOSIS 2K wins hands down offering like 1 1/3 f-stops more sensitivity! And that is more than double the sensitivity which will require less than half the light power needed in interiors...

The sensitivity I expect from the Sony CCD sensor might be in the ISO/ASA 320 at 0dB, due to the relatively small 4.54 µm (microns) pixels size.

2K has only 128 more horizontal pixels than 1080p, and in a 1080p capture those missing 128 pxs for 2K can be "masked" in post without stretching the footage, so I don't see much problems there (people do it all the time for a 2K Cinema [DCI](#) "compatible" finish).

Slow-motion is on your plans? Then get the CMOSIS 2K sensor cameras that can do up to 340p at full resolution. Unbelievable just a couple of years ago in that price range! Heck, even if it was only 2K/60p would be still a super deal!

So finally and maybe the most important factor for many is the **price**. You can get a \$1500 USD camera with the CMOSIS 2K sensor, while with the Kodak 1080p they cost 2 to 3 times as much...same for the Sony CCD.

Do your own tests as sensors are improving in all departments as time passes, and pricing of cameras are dropping in the way...

Here is an interesting camera with the Kodak 2/3" CCD and its relatively low cost at only \$3000, and the width of the body is 46mm: [Imperx Bobcat ICL-B1921](#) camera.

But it's too wide for close ups in a side by side camera configuration.

Here is a camera with the Sony 2/3" CCD, that can do up to 1080/30p and cost \$2000, the [PTGray Grasshopper 2.8 MP](#) camera. The body wide dimension is 44mm.

But unfortunately that camera is Firewire-800 (The DVR Express Core does not support it) and it's too wide for close ups in a side by side camera configuration too. But the Sony 2/3" CCD looks very interesting indeed!

The [Prosilica GX1920](#) camera has the same Sony CCD sensor and it has Gig-E interface. 53.5mm body wide size. Price \$3970

This camera can do 48 fps at 1920 x 1080 pxs. Maybe 50 fps?

Next I will only include a couple of cameras that are narrow enough for close ups in a side by side camera configuration and are low cost, do your own research as there are at least a couple of more with the same CMOSIS 2/3" CMOS sensor and more are on the way....

Basler Ace acA2000-340kc camera.



I don't think that it has an OLPF ([Optical Low Pass Filter](#)), maybe only an IR-cut filter (Infra Red) with the color Bayer versions. At this point if choosing this camera (for it's price and size) maybe try to look for an after market OLPF, but it wont be the same as a "dedicated" one put on top of the sensor by the camera manufacturer.

You won't open the camera head to install it yourself and voiding the warranty of the camera doing so, would you? Only a "crazy"* guy would do that when the camera is new...but we aren't that crazy yet, are we? :-)

*Since I am "crazy", I did it once with a relatively "cheap" \$3300 [Prosilica GC-1380c](#) 720/24p camera head, but I am a "pioneer" on this and I had to do it, other wise who would do it for me?

The AVT/Prosilica Engineers did not even know what was an OLPF back then!...go figure.

The Basler Ace camera output is Uncompressed Raw 8 or 12 bit, or Uncompressed RGB 8 or 12 bit (you can apply compression on the fly with a "Studio" recorder if you like that).

-**CMOSIS 2K** CMOS sensor (global shutter) Yes! ISO/ASA 640 at 0dB

-Dimension: 29mm (I only mention the wide side, because is the most important for our application).

-2K/Up to 340p (with [Camera Link](#) interface, consider [Gig-E Vision](#) if you need longer distances between your cameras and recorder, but that will limit the frame rate up to 2K/50p)

-2/3" format size

-C-Mount

-Price: around \$1500 USD.

There is another really small camera (26mm wide) with the same CMOSIS 2K sensor that will be introduced in 1Q of 2102. A [Ximea MQ022CG-CM](#) camera and it will cost around the same, but it has [USB 3](#) interface and the IO Industries DVR Express Core does not support that interface yet. I am working in a USB-3 small recorder though.



[Smart Cameras](#) are the right answer for really compact 3-D systems, but unfortunately they are not narrow enough for most side by side camera placement...and you have to work with a Beam Splitter rig.

Just connect a display, external storage (SSD's or HHD's) if you don't want to be limited by the internally small included RAM storage, add a keyboard (if you select a touchtone screen you don't need it)...the recording software, and a battery to power all, and that's all you need!

And also they don't offer full speed or sensor readout as a camera tethered to a better separate recorder with better specifications, so for Slow Motion (high frame rates) standalone camera heads with a separate recorder are still a better choice.

This one in development and has the CMOSIS 2K sensor as well and looks very promising [Ximea Currera-G CG022CG-CM](#) camera. The width is 66mm. They even told me that they are working in a recording software for the camera.

Ximea also offers the capability of exporting the native Raw to Adobe DNG, I've asked them if they can support CinemaDNG as well...hopefully they will.

How many MVC's manufacturers are out there? [Here](#) is a partial list. Check them constantly as they are improving their cameras with new sensors all the time.

Lenses:

Primes:

There are several C-Mount lenses in the market, I have used the Fujinon "megapixel" line before, but for some reason all of them (including the 5MP line) seems to have "disappeared" from the market...

At this point, I would recommend to look for other brands prime lenses instead.

2/3" C-Mount.

-[Kowa "megapixel" resolution](#). Specially the 25mm FL as its very narrow. For the 8.5mm and 12.5mm since Kowa does not offer those in the megapixel line, look for other brands like Fujinon, Tamron, Pentax etc. You can find many of those [here](#).



8.5, 12.5mm and 25 mm FL's (Focal Lengths).

Again, read the "Stereo Rules" chapter to find out why these are my recommendations for FL's.

-At around \$250 USD each in the "Megapixel" line.

You can try the 10 MP Kowa line versions, to see if the extra cost is worth it or not for you, and also to be "future proof" for when the 4K 2/3" sensor cameras appear, investing in "glass" is the best you can do as they don't depreciate as electronics do...but you have to be very careful to not damage them. Since the beginning put a clear UV filter to protect them, and to avoid scratch the expensive interior glass when cleaning them.

What I don't personally like of the 10MP line though is that offers f1.8 lens aperture tops...and that 1/2 f-stop offered in the f1.4 lenses might be a "life saver" in some interiors shots...

Zooms:

These zoom lenses are very expensive at \$11,700 each. They are not intended for the Indie 3-D producer, but I will put the info here just in case they drop in price in the future...or if you can rent them. But for the close ups you will need a Beams Splitter rig because they are not narrow enough.

3-D Zoom:

Fujinon XA4x7.5BMD-D3R/L



-2/3" 7.5-30mm zoom. (FF 35mm: 24-96mm comparison)

-Since it uses a 52mm filter size, the lens diameter is bigger than that, maybe 55mm?. That will be your minimum SB distance, and perhaps use a 60mm SB to avoid lenses friction.

With the 7.5mm wide FL (24mm in FF 35mm for 2K resolution) you can get the full length shots at about 3m.

I think that the Fuji guys did an excellent job with this zoom, the previous 3-D zoom started at 12.5mm and it was a "no-go" for me.

Portable Recorder:

[IO Industries DVR Express Core](#) (Digital Video Recorder).



-Dimensions: 320 x 165 x 50 mm (12.6 x 6.5 x 2").

-Weight: 1.4 kg* (3.1 lbs).

-Power: 14-30V DC, < 35W*

-[Camera Link](#) and [Gig-E](#) camera interfaces.

-Storage:

- Removable quad-pack drive shuttle
- Up to (4) 2.5" Solid State Disc (SATA)
- RAID (levels 0, 1, 0+1, 3)

-Genlock input and output. You can record from two cameras in perfect synchronization.

-Uncompressed Raw or RGB recordings.

-Price: \$6000 it comes with [CoreView](#) recording software. The standalone version recorder is a little bit bigger, but does not need a laptop and cost \$7000 except the Gig-E version that cost \$6000.

The IO Industries DVR Express Core with Camera Link interface, it only has 240 MB/s bandwidth per side (in Camera Link Dual Base, Camera Link Full do 640 MB/s and Camera Link Full plus 720 MB/s theoretically. Also see the chapter about “Uncompressed Raw recording media speed and file sizes” to make your own calculations in what you need.

I would definitely buy the [Streams 5](#) software version too, even though is an extra \$4000 USD is a one time cost and is worth it IMO, since it offers de-Bayering with compression to **Cineform FS2 4:4:4** (if you have that codec installed in your editing computer). And also you can record audio in sync in the recorder itself.

Software for the most part does not depreciate either as electronics do, and sometimes is the contrary they go up in price. For example when I bought Streampix 3/4 DVR software in 2006 it cost me \$1500 to be able to record with two cameras, now with all that you need for Stereo 3-D recordings you have to pay \$3000 bucks! (with the Audio, Pulse Generator and Cineform Raw "modules").

-This recorder will serve you for up to 4K/24p Uncompressed Raw 8 bit stereo recordings too (just in the case you can afford such cameras in the future, after you win your first movie award! Or they get cheaper...)

Portable Recording Solution:

Advantages:

- Portability.
- Uncompressed Raw and Uncompressed RGB recordings.
- 4 Removable 2.5" [SSD's](#) or [HDD's](#).
- Lower power consumption.

Disadvantages:

-Higher price and limited capacity of SSD's, you might need a lot of SSD's or a transfer and back up solution on set. Consider HDD's for 2K/24p recordings instead (4 in Raid 0).

Portable Recording Solution Pricing:

-IO Industries DVR Express Core.....	\$6000
-Streams 5 DVR software.....	\$4000
-Battery Pack.....	\$1300*
-Windows Laptop.....	\$1200
-4 256 GB MLC SSD's.....	\$1200**
- Cineform Studio Premium (for CF 444).....	\$300

TOTAL:.....\$14,000

**256 GB is good for 75 minutes approximately of 2K/24p Uncompressed Raw 8 bit.

But consider 4 256 GB 2.5" HDD's instead, having a Raid 0 array, that will give you 512 GB per side. 512 GB is good for 150 minutes of 2K/24p Uncompressed Raw 8 bit. The 4 drives will cost you like \$500 only. They are very useful, especially for long hours of recordings.

I suggest the 256 GB drives because they are more reliable than the larger capacity ones like the 512 GB ones. But use what is best for you.

4 in Raid 0 will offer more than the needed bandwidth for **Dual 2K/24p Uncompressed Raw 8 bit (108 MB/s combined)**.

There are small computers like this from [Small PC](#) that can be used as recorders too. I am working in a [Camera Link](#) and [USB 3](#) versions that will work with [Streampix 5](#) recording software. The advantage of this recorder is that you don't need an extra laptop computer. Price for the Camera Link model will be around \$4000-5000.



Portable solution additional equipment:

*-A Battery Pack like the [Mobile Power Unit](#) that [Uniforce](#) sells to power the cameras/recorder (\$1300).



-**SSD's** (Solid State Drive) for the DVR Express Core, any one of the fastest writing data that you can afford, I prefer **SLC** ([Single Level Cell](#)) Why?

Because they store one bit per cell, while MLC (Multi Level Cell) store several bits per cell, that's important for "**data integrity**" and lower bit errors, which is especially useful and important for large video files.

Also they last far more than MLC disks, supposedly 10 times more. In the long run they are actually cheaper for this single reason.

Another important factor is that SLC disks can be formatted faster. The first MLC drives required a long tedious and wearing process of "restore" (with many write passes) to new condition...if not they would become even slower that they originally were (I don't know with newer models if this is still the same way or not...).

MLC drives even in "new condition" were slower writing data at first than some top of the line SLC drives, the first

MLC disk to improve in this regard and in larger capacity for the price, was the **Intel A2 80 GB** that cost me \$540 USD...it was an expensive "lesson" that I took with that one...I still have it since they don't worth much now since almost nobody wants them...Those are the "diplomas" that I can show to people that I actually did go to "school" for learning all these stuff...nothing beats real life "school", I can tell you that already.

MLC SSD have improved even more in the writing speeds since then, but I am not sure if the formatting is in par with SLC drives...or if the data integrity is the same...I doubt it for the latest.

For some "mysteriously" reason most SLC drives seem to have "disappeared" from the market too. Even though a lot of companies announced that new models were being produced and would be released soon...but in my 18 months "break" that I took from all these, when I came back to the "scene" again most of them were gone! Not a single "trace" to be found.

In finding "clues", my "bipolarity" tell me that someone with huge interest in this industry "bought" the complete market of SLC drives...but who would have such power and deep pockets???

The most normal theory without so much "drama" involved :-)) would be that the market shifted directions since most people bought MLC drives for their "lower cost"...and also because writing speeds now are almost on par with SLC drives.

Can some "insider" on this investigate for us and let us know which one of these "theories" it is the real one please? Thanks.

The only SSD SLC that I could find for sell with enough capacity is the [Seagate 200 GB](#), but at an unbelievable price of \$3500 USD! Who may buy one of those? [Bill Gates](#)? I don't think so, that's why he is so rich, because he doesn't "burn" money like that. He prefers to donate it to the poor instead...a **wise** man indeed.

There is another [Intel SLC 20 GB](#) for only \$120 USD, that is a **great** choice to install it in the laptop for the Operating System and recording programs. You don't need much space for those, 20 GB is good enough.

For the time being we only have MLC and the new eMLC SSD's (Enterprise quality) that supposedly have 3 times more the longevity of SLC's (or 30 times more than normal MLC).

I found an [Intel 200 GB](#) e-MLC SSD for \$850, a better deal than the 200 GB Seagate.

But can either of the e/MLC's SSD's be formatted fast, and have the same data integrity of SLC SSD's needed for large video files?

That is the \$64,000 dollars question to be answered yet. Since I am broke and I don't have more money for extra “lessons” to investigate these things further, you have to do that yourself or rely in others to do that for you...not many are willing to “take the bullet” at the beginning in certain things, especially on these kind that are not cheap and you can end up with a “lemon”...

Just like me and many others with the Intel A2...what a...fiasco that product was, a big disappointment and a lot of complains arose since Intel did not offer the “upgrade” restore software for this expensive “experiment”, so we the owners of such felt betrayed and left to “die” on our own without any kind of help or even compassion for being “beta testers” of a giant corporation...

To still make it workable I had to buy an “aftermarket” software some one made for this kind of drives to “restore” them to new state, I don't remember how much I paid for it, but what I do remember is that the process was slow like I've mentioned already...and since it needs many “writes” passes, it shortens the life of the drive even more after each “restore”, what a heck man!

Ok back to topic again, I am sorry but it's difficult to forget when you have been “ripped off” like that...I hope that is a lesson that you can learn from it too. I did.

Just for comparison purposes, most Professional CF (Compact Flash) cards are “SLC” equivalent.

That's why they are preferred for Professional Photo and Video cameras. But the problem with those, are the limited writing speed and capacity.

-Laptop:

Windows OS, the CPU (Central Processing Unit) doesn't need to be “fast” per say, the only thing that needs to be fast IMO is the drive for faster boot up times, make yourself a favor and install a fast SSD it doesn't need to be big, a [20 GB SLC](#) SSD will do just fine for the OS and the programs you need for recording.

Screen resolution: 1920 x 1080 pxs at least (but preferably 1920 x 1200 pxs since you can use 2048 x 1536 pxs resolution as well, to be able to see the full 2K resolution or 4K in quarter resolution). You can chose lesser resolution if you want to, but IMO the slight increase in price for the higher resolution display is worth it, especially to be able to see the whole frame in a 1:1 pixel ratio of 2K Resolution. 1080p is perfect for the lesser cost 1920 x 1080p pxs laptops display resolution.

Also a black laptop with a “matte” screen (not “glossy” or shiny) is extremely helpful, especially in outdoor shootings...

Make sure it has a SATA connector to connect to the DVR, otherwise use an express card adapter. But having a dedicated SATA port in the laptop is a must if you plan to make your back ups with such laptop too, see the explanation under “Workflow- Transfer of media” chapter. Also I think you need to power separately the SATA adapter...more batteries and cables to lug around...

Buy a laptop with removable batteries and bring some recently charged on set, or have a “power to go” kind of battery packs/adapters to be ready when you run out of juice...and you will after a long day of shooting.

More additional equipment:

-A couple of Tripods (one for the camera and one for the laptop or use a folding table/cart for the laptop.

-A Stereo Slide Bar like the [Jasper Heavy Duty](#), and maybe a small Beam Splitter rig for tight close ups and macro work.

-Maybe a desktop computer (that could be also your editing machine) to copy all the data alternating the SSD's so you can shoot all day long with those 4 SSD's. Otherwise buy more SSD's...

And that's it all you need for Professional Cinema 3-D equipment.

And after you "rob" a bank, I'm sorry I meant to say after you borrow the money from it :-), there you go...you are almost ready to become "famous" with your beautiful stories told in the best way possible, Motion Pictures in 3-D!

But instead of buying all of that, consider renting part of it, at least the portable IO Industries DVR Express Core.

I know that IO Industries directly rents that item, and that some of their resellers work with rental houses already. MVC's for Cinema work have been finally accepted by the Cinema Industry! It wasn't easy though, since it took like 5 years to get to this point...

Considering the Recorder/Software and SSD's pricing, and after reading the workflow chapter about "Media Transfer and back-up" you might want to consider recording to a single computer directly, instead of using the IO DVR Express Core though.

A computer with 8 3.5" HDD's (Hard Drive Disks) and running [Streampix 5](#) will offer more capacity of recordings, and hence will be much cheaper in the long run (and if you have Windows 3-D video editing software, it can be your editing machine as well)...also if you prefer to compress on the fly.

2K Cinema Studio Recorders

Advantages:

- Uncompressed Raw, Uncompressed RGB and Compression on the fly recordings.
- Up to 8 removable HDD's with more capacity than SSD's, and cheaper.
- Back ups of video possible in the same computer, at the time of recording also with Raid 1 (2 drives) or raid 10 (4 drives) configurations. This saves a lot of time backing up your video.
- It can be your export/de-Bayering machine as well, and if you work with Windows 3-D NLE's software your editing machine too.
- The use of a large display monitor.

Disadvantages:

- Not so portable.
- Requires more power than a portable solution.

Studio Recording Solution Pricing:

- Recording computer (with included internal synchronization).....\$5000*
- 1920x1200 pxs 24" monitor.....\$500
- 8 1 TB** HDD's for recordings.....\$1000
- [Streampix 5](#) multi cameras DVR software.....\$1500
- Norpix Audio and Pulse Generator "modules".....\$1000
- [Cineform Studio Premium](#) (to de-Bayer to Cineform 444).....\$300

-3 Car Batteries plus power inverter.....\$500
 TOTAL.....\$9,800

****4 Raid 0 arrays of 2 disks configuration each. 2 TB is good for 240 minutes (4 hours) approximately of 2K/60p Uncompressed Raw 8 bit per side of video. The extra 2 Raids are for backups of media.**

I suggest the 1 TB drives because they are more reliable than the larger capacity ones like 2 TB or 3 TB. But use what is best for you.

***Dual up to 2K/60p. Silent machine** (only streams data to the disks, and hence the CPU does not to be super fast. Also a **single processor** permits a large fan that can be at minimum speed).

Camera Link Base interface (10 m/33 ft cameras/recorder distances).

If you want to compress to **Cineform Raw** on the fly, up to **2K/48p** recordings is possible with current fast **Dual Processors**. A Single Processor can do up to 2K/24p. Add \$500 for the Norpix “Cineform Raw module”, plus \$1000 more for a fast double processors.

Since this kind of recorder is more noisier because we need the 2 processors fans at faster speed to cool off the CPU's, you need longer distances than 10 m between your cameras/recorder, and **Gig-E Vision** is the way to go offering up to **100 ft/33 m** camera synchronization. But **Single Gig-E** will limit up to **2K/50p**. If you want 60p, then get **Double Gig-E** cameras like the **Prosilica GX-1910** than can do **1080/60p**.

The advantages of Cineform Raw compression is that you can have ready to edit footage, and also that you can use small laptop hard drives for recordings, and hence the machine can be smaller in size too.

With this longer distance solution you also need a touch tone screen close to the cameras for manual focus check, preview and controlling the computer from a distance.

Slow-mo: (Uncompressed Raw only)

You need an extra \$1000 **Camera Link Full** card (640 MB/s) in the computer for 3-D recordings. And with 2 Raid-0 of 3 fast SSD's per side, you can record **2K/289 fps*** 3-D!

***You can record 2K up to 325 fps with Camera Link Full plus (720 MB/s).**

These prices is what I would charge you to build a recording machine, you can try building it yourself...but you will need professional computer expertise to select the right parts. A double Independent Bus Professional MOBO (Mother Board) and know how to integrate the internal camera synchronization “pulse generator” system, are the most important key parts on the recorder!

They are not “easy” to build, if you don't have proper “back-up” technical support. And they take time to be built, and get it fully tested...time is money.

If you don't know how to build it yourself (not many people besides the “insiders” in the industry can “get it right” the first time...like what happened to me at the beginning for example:-)), try to buy it from Norpix or IO Industries instead...

Here are some pictures of such recorders:



D&A Rubio S-3D Recorder



I can build either configuration, the “Server” or "Desktop" bodies.

Note: the desktop configuration permits an extra drive bay and you can install a LTO tape drive there if you want to, the server configuration also permits that but you will have to have your DVD/Bluray drive in an external enclosure for when you need it (you wont need it much, unless you use it as an editing computer and burn DVD's or Blurays there too...)

An LTO tape drive is a very important part for long term video archival! (It's not included on the \$5000 pricing though, since some of the fastest [LTO 5](#) cost \$3000 or more! This one shown on the picture cost me \$1500 with the free recording software included plus the internal interface card...really cheap at the time, but kind of slow writing files....you get what you pay for!

With these kind of studio recorders you can have a secondary small monitor close to your cameras to check focusing, and if it is touch screen you can control and record from there too.

[Norpix](#) "Lunch Box" type of portable computers with Camera Link Base interface. They can do Dual 2K/60p Uncompressed Raw 8 bit recordings, into 2 Raid 0 arrays of two 3.5" HDD's each:



IO Industries Luggable PC



Up to **2K/48p** Recorder: (Gig-E Interface)

D&A Rubio S-3D Recorder



Up to **2K/30p** Recorder.

Norpix SmallPix:



What do you need, portability that it wont be that anyways if you don't add enough SSD's capacity for recordings...or a “Studio” recording version?

Do your own math, and see if you have the means for either one.

Additional equipment:

-A portable system of energy to power the computer outdoors. You can use a portable generator, but most of them are extremely noisy...

Instead I use normal battery cars (a fully charged large one will last like 2 hours) with a Power Inverter (PI). Or a car running that is more silent than a portable generator. A 2000 PI watts will do, like this one here:



-A Stereo Slide Bar like the [Jasper Heavy Duty](#) and a Tripod.

That's it for your basic Studio System.

Besides light reflectors and lights...but you have to search for lights info in another book...with the info here in this one, you won't need much of those for interiors anyways!

Before going any further with the workflow, I will start with this since sometimes the "end" (of the production) is sometimes more important than the "beginning" of it...

And IMO the editing computer is one of the most important gear for video productions. Why? Because in editing is where you will spend more time in the production chain...that is, if you aim for the best work you can do.

If you are an Independent 3-D movie producer, you may have a limited budget, and probably your editing computer will have the maximum drive capacity allowed by desktop computers...8 drives*. (besides the Operating System & Programs drive).

* Single drives are not recommended for video editing: With information I've got from [Tom's Hardware 2012 HDD Charts](#) there is a Seagate 3TB that can do [minimum read of 93.5 MB/s](#) which is great...The average and maximum read speeds don't matter for a fluent video palyback.

But also that minimum read speed is when drives don't have much data written into them, because when they are being filled they go from the center to the "outer" space of the disk for writing/ and later reading the data. And that circumference is greater than in the center of the disk...so that reduces the speed in the way.

So at half capacity the speed will suffer accordingly, to around be **46 MB/s**...Raid arrays do not suffer from this issue.

Speaking of the OS and programs drive, I recommend a Solid State Disk SLC (Single Level Cell), this is for added safety that your work wont be lost if the drive fails!

You have 3 choices here for your video data drives. One is to make 4 Raid 1, the second is 4 Raid 0, and the third is 2 Raid 5 arrays...

Raid 0 you can get full combined minimum speed writes and reads, but also you double the risk of failure of single drives too.

Raid 1 will secure your work into 2 different drives ("original & copy") by "mirroring" the data (although I have not tested this array for video performance yet, and at this point I don't have new formatted drives to do those tests. Supposedly increases read speeds by 50% of single drives).

Raid 5 array of 4 drives that supposedly "saves" the data if one of the 4 drives fails, and because of this many video editors prefer it...the speed is 3 times of single drives...but going this way you have to make the final de-Bayering and renders in the opposite drives side. The Raid capacity is of 3 drives.

Raid 10 array of 4 disks has the speed of 2 disks in Raid 0 plus the security (mirror) of Raid 1. The same as Raid 5, you have to make the final de-Bayering and renders in the opposite drives side. The capacity is of 2 drives.

Decide what is better for you, to be safe or to take risks with higher speeds, or need the safety and a little more increase in read speeds...The writing speed here does not matter much, because once you have your data in the drives, the playing (reads) is the most important for a real time editing workflow. The final de-Bayering and renders are slow anyways. Don't render anything into Uncompressed RGB until the end of the editing work! But save your work constantly if your NLE does not have an auto save function.

Like I said, you will spend in 3-D editing a lot of hard working time...if one of those drives (single or in Raid 0 configurations) fail in the middle of your editing work, you might want to smash your computer into pieces and throw it through out the window...that is the worst thing it can happen in all your workflow!

For me, I think that a Raid 1 array is better for (2K/24p) 3-D video editing...since is extremely time consuming,

way more than 2-D video editing.

So if going with Raid 1 configurations, that leaves the computer with only "4 drives". You will need 2 of those drives for each side of your video, left & right.

Plus the other two drives for final de-Bayering and renders (maybe to render both sides at the same time into the two separate drives as well, if the computer has Dual CPU's...). Perfect!

Now, you have to look into the minimum read speed performance if you want to edit in "real time"...that is when you hit the play button, everything will look as recorded.

These are the choices of read speeds for Raid's with single drives with minimum read speed of 93.5 MB/s.

-2 drives in Raid 1= 140 MB/s

-2 drives in Raid 0= 187 MB/s

-4 drives in Raid 10= 187 MB/s

-4 drives in Raid 5= 280 MB/s

With Raids of 4 drives, you have to make the renders in the opposite drives.

Those speeds will dictate what resolution and frame rate to use in your Uncompressed Raw video. That applies to **Cineform FS2 4:4:4** and **CinemaDNG Uncompressed**** as well..

** Workflow still in the works

Just to give you an example, these are some speeds of Uncompressed Raw video (all at 8 bit):

-2K/24p is 54 MB/s,

-2K/48p is 107 MB/s

-2K/60p is 133 MB/s.

-3K/24p is 120 MB/s

-3K/48p is 220 MB/s

-4K/24p is 212 MB/s

After you have your equipment ready you are “almost there”...but hold your horses buddy, before you prepare to receive an award for your 3-D movie, you have to do some “homework” first (just like I had to do, otherwise I would not be writing this book)...I won't tell you to go to College for 4 years (or more for your “masters” degree and others), not even to go to one “workshop”, you can do both if you want to, have the money and time, and think that a piece of paper is valuable for you.

But at this point I don't think that there are any “schools” that can “master” this new way of doing things in 3-D Cinema, so you have to “stick” with me regardless if you like me or not. Sorry that's real life...Some times I did not like my teachers either, but I had to “bear with them” in order to learn...or even just in order to pass the grade, even if I did not learn much :-)

But hey see the bright side of things, it's “free of charge” (nothing is really free in this life, not even the air because if you don't work so you can put food on the table to eat, I bet you that you can not go too long breathing “free air” :-)).

I spent a lot of money, around \$50K USD and I went bankrupt because of my “invention”...or better said 3-D system integration.

I also spent thousands of hours in research, and lots of time on “hands on” the field to be able to “discover” these 3D systems and workflows. But I offer it to you at no cost. Other than reading my boring explanations...

If you think that at the end you found something useful and want to donate something to “the cause” (my cause of having to support two beautiful boys...**D&A Rubio**) I will let you know how you can do that at the very end of this document (that is not even a “book” per say, because I don't have money to get it published, and even if I had it, I think that is better to give things for donation than to charge fixed prices for them...but most humans are not ready for that...yet).

That kind of way of “doing business” would change the world 360 degrees in the right direction. But we have to be patient for that kind of thing to happen as well.

Please make yourself a favor and shoot [Parallel](#) for most of your work (see the chapter “Parallel vs Convergence” for more details), you can do your horizontal Parallax adjustments in post.

When shooting Parallel stereo we must “crop” the horizontal resolution to set the horizontal Parallax values, and that's ok don't worry, the 2-D version will be left intact, while the 3-D version will have a little less resolution but in the 3-D projection (applies for 3-D HDTV too) the “over lapped” stereo views will make up for the individual side lost resolution.

These are good starting points, but they can be flexible, you can get closer or farther away from these, but remember to change the Stereo Base accordingly when doing so.

I will put the comparison Full Frame (FF) 35mm Focal Length in both, 1080p and 2K resolutions.

These are based in a 5.5um (micron) sensor pixel size.

NP=Nearest Point

FP=Farthest Point

SB=Stereo Base

m=meters

mm=millimeters

Please go to next page for the chart:

Format Size: 11.26mm wide

2K Crop Factor vs FF 35mm: 3.197x

1080p CF: 10.56: 3.409x

These are only "starting point" suggestions and are with the FP at infinity. If the FP is closer, use a Stereo calculator instead. See the Stereo Rules chapter for more information.

Full Length Shots: (Wide Angle)

8.5mm lenses (FF: 2K 27.1mm, 1080p 28.9mm)

1/23.2th Rule

2K: NP 3.4 m, 146mm SB

1/24.7th Rule

1080p: NP 3.2 m, 129mm SB

Mid Length Shots: (Normal)

12.5mm lenses (FF: 2K 39.9mm, 1080p 42.6mm)

1/34.2th Rule

2K: NP 2.5 m, 73mm SB

1/36th Rule

1080p: NP 2.4 m, 66mm SB

Close Up Shots: (Mid-Telephoto)

25mm lenses (FF: 2K 79.9mm, 1080p 85.2mm)

1/68.4th Rule

2K: NP 2.5 m, 36mm SB

1/73th Rule

1080p: NP 2.4 m, 32mm SB

If you are going the more portable IO DVR Express Core route with SSD's, these are the choices:

You would need an offloading/download transfer and back up plan on set if you don't have the budget for lots of SSD's, and given the current prices of them, that will apply for most Indie 3-D producers for some time to come yet.

IO Industries sells a “download module” to theoretically speed up the downloads 4 times faster than “normal”. For only \$1300. That sounds good on paper, but the limiting factor here will be the writing speed of your editing/download computer drives. I would say that a regular “external drive” stripped down case that has a drive/computer SATA connector will do just fine, but do your own tests on this issue if it's important for you.

And if you will be using the single desktop route for downloading and back ups on set, consider to directly record there instead of using the IO DVR Express Core. A computer with normal 3.5” HDD's and running Streampix 5 will have way more capacity for data than SSD's (and it can be your editing computer as well if you have Windows video editors)...Also if you prefer to compress on the fly using Cineform Raw. What is the advantages of this? Ready to edit video.

There are two routes for download/backups on set, 2 laptops (for up to 2K/30p Uncompressed Raw footage) or a single desktop computer (for up to 2K/60p Uncompressed Raw).

No matter which route you take, please make sure that after formatting the SSD's for new use, make at least **1 copy** of the video files in separate drives! (if you are not using Raid 1 arrays of 2 drives). Otherwise you might end up dead telling the actors and crew that all the previous work has been “lost”...if that happens, you better be lost as well! :-)

They might forgive you if one of the SSD drives got “broke” during recordings...but after that? Well this might be also a “good excuse” to make if you are that kind of people that in order to be “saved” make all kinds of lies...I mean “excuses” :-)

I shouldn't have told you that one, otherwise how on Earth I might fire you for loosing the data now? :-)

Also remember what I said about the speed of reformatting SSD's in the 2K Cinema/Equipment section.

2 Laptops: (Uncompressed Raw 2K/24-30p)

Have a couple of laptops with at least one dedicated SATA connector (or trough an express card adapter) and one USB 3 port, the only limiting factor here will be the writing speed of the HDD's. Use 3.5” HDD's with removable drives preferably in an external enclosure.

You would need at least 2 drives, one for the left side and one right side video, plus 2 for extra back-ups. So that makes 4 of them.

With a **minimum write** speed of single drives at 93.5 MB/s as drives are getting full, the speed will suffer accordingly. By half capacity it will be 46 MB/s...Raid arrays do not suffer from this issue, so get a Raid 1 (preferably) external HDD storage.

A single Desktop: (Uncompressed Raw 2K/48-60p)

If you don't like the 2 laptops route for the slower writing process of single drives when getting full, and also need to increase the speed for higher frame rates like 2K/60p, then a single desktop computer will do. Why two laptops and only one desktop computer?

Because in the desktop (if it has double separate independent bus MOBO-Mother Board- architecture) you can offload the two video sides simultaneously, while in the laptops only one at the time, and time is “money”...

An extra advantage in a desktop computer is this:

Single HDD's are relatively slow writing those “gigantic” Uncompressed Raw files, so it's better to have an array of 2 disks in Raid 1 (per side). And that increases the speed by 50% in comparison to empty single drives, and it will save time also since it will write the back up copy simultaneously.

Just to give you an example of the downloading/writing speed of 2K/60p Uncompressed Raw 8 bit files is this with fast drives.

With the HDD's that can do a **minimum** writing speed of 93.5 MB/s (not average), how long will it take a minute of video that is 7.5 GB/min in size and with 133 MB/s bandwidth to be transfered with and Raid 1 array of 2 drives?

$93.5 + 50\% = 140 \text{ MB/s}$.

$133 / 140 = 0.95 \times 60 = 57 \text{ seconds}$

You can use Raid 0 arrays of two disks to double the speed of single drives (187 MB/s), but you also double the risk of failure, plus you will have to spend more time doing the back ups too.

But the problem with this Raids approach is that when you fill up the drives you have to be **extremely cautious**. Why?

Because when you make a disk array in a computer and then you remove the drives (with easily removable hard drives), is a nightmare to “get them back” again...so you have to write down the (Windows OS) drive letters assigned to each of the Raid arrays, and number your drives and positions of them. Also make annotations which contain the original left or right sides and their respective back-ups. Do that for each set of “fresh” drives...

Even doing that, after a while sooner or later you will run out of letters in the alphabet, (after 6 sets or so)...

All that seems like hard work right?

It is, nobody said that good things in life were easy, and there is nothing better in Cinema than 3-D 60p Uncompressed...

Try to see what workflow is better for you, if you can carry a desktop computer or 2 laptops on set...

Even after that, if you seem to be “let behind” transferring and making the back-up copies with just 4 SSD's, buy an extra set of SSD's, or more...depending on your speed of shooting.

Do that unless you have the budget to buy a lot of SSD's for the whole day of work. If you consider the price of film stock vs SSD's that last for hundreds or thousands of writes and reads, they are still cheap in comparison!

If you choose to have lots of SSD's instead of carrying 2 extra laptops or a desktop on set, those still have to be downloaded overnight for the next day of shooting anyways...unless you have a mega budget for SSD's for two days of shootings or longer...To calculate what route you can go, see the chapter “Uncompressed Raw recording media speed and file sizes”.

Ok there are different ways to do things; I will present them to you as they were presented to me since the beginning of this project with [Streampix 5 DVR](#) software.

1-De-Bayer to Uncompressed [RGB](#) (AVI or MOV)

In 2006 there was only this choice to preserve the best quality of the Uncompressed Raw video, but the process is slow if you want the best de-Bayering quality like Laplacian 1 in Streampix 5 (like 2:30 minutes per minute of Raw 1080/24p with a Quad Core 2.4 GHz processor). With a 3.6 GHz i7 processor I think that time can be reduced to 1:1. Plus if your computer has double processors you can do the two sides de-Bayering at the same time.

A fast workflow is to just select what parts of the sequence you want to de-Bayer. This saves a lot of time!

And the files sizes will be 3 times that of Raw files. Uncompressed RGB 2k/24p 8 bit files will be 8.4 GB/min.

Uncompressed RGB is supported in most Professional NLE's (Non Linear Editors), except Vegas Pro 11 that can not import it yet.

But even this file size is kind of large in comparison to what you might have worked before (extremely compressed video), but nothing compares to it in terms of rich saturated color, dynamic range, clarity and cleaner images that they produce!

2-De-Bayer to [Cineform](#) HD FilmScan 2 4:4:4 (AVI or MOV)

Later on in 2007 de-Bayer to Cineform HD was possible. The advantage of this? 4 times less the size of Uncompressed RGB files (4:1 compression*) and around 75% the size of the original Uncompressed Raw file.

*With Cineform HD Film Scan 2 4:4:4 (12 bit) compression quality.

Doing the Cineform 4:4:4 compression, you are automatically “upgrading” your 8 bit footage to 12 bit...Even the Uncompressed RGB 8 bit will beat the Cineform 12 bit in any regard, that's why I say that I prefer 8 bit Uncompressed than higher bit Compressed (see the "Uncompressed vs Compressed" chapter).

Cineform also has an excellent detailed “tune up” workflow with First Light.

Now since **FilmScan 3 4:4:4** quality will be possible in Streampix 5 too, I will probably use it from now on since it offers only 2.6:1 compression, or 112% the size (approximately) of the original Uncompressed Raw files.

Update 4-4-12: David Newman from Cineform says that FS3 quality is “overkill”...and they wont support it “mainstream” anytime soon (only SI-2K software has it available I think...). He says that after [NAB 2012](#), they will release the new Cineform codec v8 that will have “rate control”. So FS2 quality supposedly will be much better.

The advantage of Cineform compression over other codecs like [ProRes](#), Avid [DNxHD](#) or [Edius HQX](#) is that the compression is not based on bit rates caps like those do, and hence you can get the same quality of 4K or 1080p footage regardless of the frame rate, at the same Cineform quality settings. With the others if you increase resolution or frame rate, you lose more quality since the video ends up with more compression.

3-Export to Cineform Raw (AVI or MOV)

This is not a de-Bayering process, is just exporting or "trans-coding" the footage, a slightly faster process than de-Bayering. With footage I shot in 2009 the compression ratio of Cineform Raw FS2 vs the original Uncompressed Raw files was 6:1. And the size was around 500 MB/min for 2K/24p.

But the IQ suffers even more than with CF FS2 444 as shown in the “Uncompressed vs Compressed” chapter.

Update 3-2-2012: Now it's possible to export to Cineform Raw **Uncompressed** with Streampix 5 too.

Update 3-29-12: David Newman Cineform's CTO says that he does not see an increase in IQ of Cineform Raw Uncompressed, and hence he will not spend time fixing the Streampix 5 exporting problem to this codec. So at this point I only recommend to de-Bayer to Cineform HD FS2 or FS3 4:4:4 codec.

-The IO Industries [DVR CoreView](#) software charges an extra fee to be able to de-Bayering/export to Cineform HD/Raw (last quote I've got from Uniforce, was in the \$1500-5000 price range). If you are interested on this, contact IO Industries directly instead.

But why bother? Just buy Streams 5 (\$4000) and you will be set, plus you can record audio in sync in the DVR Express Core too.

Streampix 5 charges \$500 to be able to export to Cineform Raw, but at this point you can de-Bayer to Cineform FS2 4:4:4 with out an extra license fee.

4-Export to [CinemaDNG](#) Uncompressed

This approach is another option and the best IMO since keeps all the Uncompressed quality , this way you keep the files at the original Uncompressed Raw size (3GB/min for 2K/24p), but at this point it seems that you have to de-Bayer to other video codecs like Cineform to be able to edit your footage. If this is indeed the case, I don't see the point of it right now (until it has better NLE support) since you can de-Bayer the native Uncompressed Raw files directly from Streampix 5 or Streams 5 to Uncompressed RGB, or if choosing compression, to Cineform FS2 4:4:4.

Anyways, I already have asked both, Norpix and IO Industries the possibility of supporting it too...and maybe recording directly to CinemaDNG as well.

As of today, like I mentioned there isn't any NLE's that support native Uncompressed Raw files that MVC's recorders write. Anyways if they were supported, all Raw video must be “rendered” in all editors, that is the de-Bayering or demosaicing process, so no “time savings” in neither workflow. And if the de-Bayering or render is good quality, I can tell you this, is slow with current desktop computers. The best quality, the most slow the process becomes. You can choose the de-Bayering algorithm that meets your quality criteria and speed/patience.

The only advantage in a supported Raw editor is that before rendering the video, you can do your cuts on the time line and only render the final intended movie shots...that alone is certainly a lot of time savings with this workflow.

I hope that at least one or two MVC' recorder software developers native Raw files will be supported by some video editors in the future...in this regard recording directly to **CinemaDNG** or **Cineform Raw** has a clear advantage.

Note about Compression in post:

If you decide that at this point you are going to compress (de-Bayer or export) in post the Uncompressed Raw video. Why shoot Uncompressed Raw to begin with? Besides higher frame rates and the use of a small "cooler" recorder, well that is the “secret” to be “future proof”, you will keep the original Raw files uncompressed just like film is, an Uncompressed format.

Also (for the most part) in camera/recorder de-Bayering and compression (in real time), is not as good as a detailed slow high quality de-Bayering/compression in post.

If you choose the compression route in post, as times passes and you might want to “re-master” your movie (or someone else besides you) you or them will have the “digital negative” intact...to work from again.

Resolution: 3072 x 1620 pxs. (pixels).

I think that a 3K Bayer capture to 2K finish is better than 2K Bayer/finish. Especially for 24 fps and the 2-D movie version, but if you don't plan on doing that version for BIG Cinema screens projection, just skip this chapter and decide for 2K Cinema Bayer/finish or jump directly to 4K Cinema Bayer/finish for a possible IMAX 3-D projection...

But if 3K/48p is still appealing to you read on buddy!

Some of the advantages of 3K Bayer capture over 4K Bayer are these:

- 1- 56% the files sizes and bandwidth needed (at the same frame rate).
- 2- 4/3" format size vs S35mm in 4K (with the same sensor 5.5um pixel size).
- 3- The use of f2 DOF. Half the light needed vs f2.8 in S35mm/4K.
- 4- Up to 48p Uncompressed Raw 8 bit workflow with only one Camera Link base recorder.

Here are some resolutions with different sensor cameras with the Cinema 1.89:1 ratio, and the factor size vs 2K resolution:

2048 x 1080 pxs = 2211840

1" CCD (Sony ICX694) 2750 x 1455 pxs = 4001250.....1.80x

4/3" CCD ([Kodak KAI-08050](#)) 2844 x 1500 pxs = 4266000.....1.92x

4/3" CMOS (Dalsa Falcon2 8M) at 3072 x 1620 pxs = 4976640.....2.25x

You can easily work with any of those and have a clean 2K finish.

Even though the Sony 1" CCD (1080/24p) has a little bit less resolution than the others, the advantage of it over the other cameras is the use of more affordable 1" C-mount lenses that have a f1.4 maximum aperture.

But at this point the only camera that has that sensor is the [Prosilica GX2750](#) (\$3975) , and it's a double Gig-E interface camera. You would need one portable recorder (DVR Express Core) per camera for 3-D recordings.

But since 2750 x 1455 pxs at 24 fps Raw 8 bit is only 96 MB/s bandwidth (2750 x 1455 x 24 x 1=96030000). Single Gig-E might be fine.

The sensitivity I expect from that sensor might be in the ISO/ASA 320 at 0dB due to the relatively small 4.54 µm (microns) pixels size.

Keep an eye on other camera manufacturers future offerings with this sensor. I want Camera Link or USB 3 interface.

Cameras:

[Dalsa Falcon2 8M cameras.](#)



Sensor: CMOS with global shutter

Resolution: 3328 x 2502 pxs.

Frame rate: 90 fps at maximum resolution. At 3072 x 1620 pxs I think that they may reach 120 fps!

ISO/ASA at 0dB gain: I am expecting ISO 640, but even if it's only ISO 320 is ok.

Wide dimensions: 60mm

Price: \$5460

There are a few 8MP CCD cameras that can do at least 24 fps at close to 3K resolution. Like the [JAI-AB-800CL](#).



Body wide size: 55mm.

Sensor Kodak CCD (global shutter).

Pixel size: 5.5 microns.

ISO/ASA 240 at 0dB gain.

That camera at 2844 x 1500 pxs (approximately at Cinema 1.89:1 ratio) can run at 24 fps. I see the benefit of extra horizontal resolution because we are going to shoot parallel and do a HIT in post.

Then when we are done editing we can output our final delivery to 2K or 1080p which yield a better final resolution than with 2K or 1080p Bayer resolution capture.

The wide size of the cameras is 55mm and that is the minimum Stereo base you can use in a side by side configuration. I wish that that it was at least 45mm like the Kowa 4/3" C-mount lenses.

Price: \$5500 each.

Lenses:

These are good for the JAI C-Mount cameras, but they may be used with the Dalsa Falcon2 with an C-Mount adapter too, but they might show some vignetting on the edges at full wide resolution.

[Kowa 4/3" C-mount 16mm, 25mm](#) and [50mm](#). They are only 45mm in circumference which is good, and have a maximum lens aperture of f2 that is very good also.



Price: \$1200 each in average.

For the Falcon 8M you can use any photographic lenses available (besides the Kowa 4/3") like Nikon, Canon etc with lens mount adapters. But with those the maximum aperture is f2.8. Except the 50mm line that there are even some f1.4, and if using a Beam Splitter rig then since it robs like 2 f stops you will end up with a f2.8 equivalent as well.

Don't take the maximum lens aperture for granted, you will be needing f2 in interiors if you don't up the camera gain or bring in more light, which both things are something I don't recommend too much. I prefer fast lenses instead.

[Here](#) are some 15mm, 24mm and 50mm 35mm lenses. (use mount adapters for your favorite mount brand). I prefer the [Nikon AI-S Manual Focus](#) line.

3K Recorders:

See the Cinema 2K Bayer/Equipment since those can be used here as well.

Dual 3K/48p **Uncompressed Raw** 8 bit recordings with the IO DVR Express Core are possible. And Stereo Uncompressed Raw recordings using a single computer with 2 Raid 0 of 4 drives configurations (with combined 240 MB/s **minimum** writing performance) 3K/24p requires half the bandwidth, media speed, and file sizes...so 2 drives in Raid 0 will do instead of 4.

Also see the chapter about “Uncompressed Raw recording media speed and file sizes” to make your own calculations.

If going this route, for me 3K/48p Uncompressed Raw 8 bit tops is the way to go for now, since it gives 13.5 GB/min files (per side).

Cineform Raw compression on the fly using a single computer?

Not possible at this time for 3K/48p, you need two machines, one per camera.

Dual 3K/24p might work though...

But with 3K/48p, Camera Link Base interface is needed (10 m/33 ft).

3K/24p double Gig-e works better (30 m/100 ft cameras/recorders distance).

These are the lenses you would need for 3K Bayer resolution:

I will write the Full Frame 35mm Focal length comparison as “FF”.

NP=Nearest Point

FP=Farthest Point

SB=Stereo Base

m=meters

mm=millimeters

Please go to next page for the chart:

These are only "starting point" suggestions and are with the FP at infinity. If the FP is closer use a Stereo calculator instead. See the Stereo Rules chapter for more information.

These are at full horizontal resolution

Format Size:15.64mm wide (Kodak-2844x1500 pxs)

Format Size 18.43mm wide (Dalsa-3072x1620 pxs)

Crop Factor vs FF 35mm: 2.301x

Crop Factor vs FF 35mm: 1.953x

Kowa 4/3" Lenses

35mm Lenses

Full Length Shots: (Wide Angle)

16mm lenses (FF: 36.8mm)

15mm lenses (FF: 29.2mm)

1/31.5th Rule

1/25th Rule

NP 4.4 m, 139mm SB

NP 3.5 m, 140mm SB

Mid Length Shots: (Normal)

25mm lenses (FF: 57.5mm)

24mm lenses (FF: 46.8mm)

1/49.2th Rule

1/40.1th Rule

NP 3.4 m, 69mm SB

NP 2.8 m, 69mm SB

Close Up Shots: (Mid-Telephoto)

50mm lenses (FF: 115mm)

50mm lenses (FF: 97.6mm)

1/98.5th Rule

1/83.6th Rule

NP 3.4 m, 34mm SB

NP 2.7 m, 32mm SB

For close ups when the FP point is closer like in indoors, you can use a wider Stereo Base.

But for outdoors with the FP at infinity, since you can not use current 3K cameras with a 32-34mm SB in a side by side camera configuration, you can use the smaller 2/3" 2K resolution cameras and lenses. In close up shots resolution is not so critical like in busy wide angle shots.

Close Up Shots: (Mid-Telephoto) with 2/3" 2K cameras.

25mm lenses (FF: 2K 79.9mm, 1080p 85.2mm)

1/68.4th Rule

2K: NP 2.5 m, 36mm SB

1/73th Rule

At this time, I only recommend the **Cineform FS2 4:4:4** de-Bayering that I've talked about in the "2K Cinema Bayer/ Workflow" chapter.

But when **CinemaDNG Uncompressed** will be better supported in Professional video NLE's (Non Linear Editors), export to that codec will be the best workflow.

Resolution: 4096 x 2160 pxs. (pixels).

If you did not even read the “2K Cinema Bayer” chapter and jumped here to be “future proof”, please go there first to see the advantages of that resolution and equipment. Like shooting 2K/60p for example.

At this point, I don't recommend above 4K/24p resolution/frame rate for this MVC's Uncompressed Raw solution. 4K/24p 8 bit tops is what I recommend.

After reading the "2K Cinema Bayer" chapter and if you still think that you are going to produce a master piece that will be shown in IMAX 3-D Cinemas, or that people would want to see for generations to come, sure go ahead...if you can deal with the price and workflow of 4K/24p Uncompressed Raw.

If its good work, even if its only “2K Bayer/finish” resolution people will still see it in the future, just like now many watch Standard Definition shows (480i) in their 1080p HDTV's...some of them were even shot in B&W!

If your target delivery is a 2K finish, and don't like the 2K/60p route and prefer 48p, then go to the "3K to 2K finish" chapter, you can shoot 3K/48p for a clean 2K/48p finish. There are also other benefits besides 48p, and even when shooting only 24p.

Also see the “DOF and 3-D” chapter to make a more informed decision at the end. With current Bayer sensors designs (5.5 and 6 microns pixel size), with this 4K resolution you will be working in the S35mm format. For a descent DOF, the widest open lens aperture you can use here is f2.8 instead of f1.4 in the 2/3” 2K format or f2 in the 4/3” 3K format. That means more lights (or gain which means added noise)...choose your favorite “poison”.

4K Bayer will give you a “clean” 2730 x 1440 pxs finish resolution (1.5 factor), but since that resolution doesn't exist for delivery, you can resize it to 2K finish (2048x1080 pxs) and it will give you even cleaner resolution than 3K Bayer to 2K finish. But like I said, having the other factors into account, I prefer 3K Bayer/2K finish.

I recommend if shooting 4K Bayer, then to do your finish in the same resolution. At least all your trouble can be “justified” at the end.

Why?

Because with this kind of level of resolution, you don't have “critic” resolution issues as in 2K Bayer/finish, so even 4K Bayer to 4K finish is acceptable, especially for 3-D projection.

So this format is clearly a winner in terms of sheer resolution over 2K Cinema Bayer or 3K Bayer/2K finish, but it opens another “can of worms” regarding DOF, light needed for indoor shootings, a substantial increase in the bandwidth/file sizes (4 times more than 2K) and a significant increase in cost of equipment...especially in camera heads pricing over the 2K cameras...and SSD capacity. You will need more with 4K.

Plus you will spend more time transferring, copying and de-Bayering your footage. And more power in your computer editing 4K resolution. Consider all this as an extra expense as well.

For me 4K is not worth the trouble since 3K to 2K finish is good enough for Cinema projection in most regular screen sizes (35 feet wide).

Until someone produce a 2/3" 4K sensor like I've proposed in the chapter "Vision Stereo 3-D Cinema camera system" (with diagonal pixel design), we are "stuck" for the time being with traditional Bayer sensor designs. And those are S35mm. Here is a 4K camera with such sensor.

Sensor: Dalsa CMOS with global shutter.

Resolution: 4096 x 3072 pxs. Pixel size: 6 microns.

Price: \$6815 each.

There are other MVC's heads with [4K CMOSIS \(12 MP\)](#) sensors that are coming next year (some time in 2012, I hope if everything goes as planned...), but with the current pixel size/design (at 5.5um) the sensors will be close to S35mm in size ($4096 \times 0.0055 = 22.5\text{mm}$). The good thing is that they will have global shutter, yeah! ISO 640 at 0dB gain

One of them is from **IO Industries**, and it will look something like their current [Flare 2MP and 4 MP](#) line of cameras:



The price I am expecting for such camera heads? I think that at the beginning they will be in the **\$15,000 USD** range tops. Why more expensive than the Falcon2 12M cameras? Higher frame rates. The CMOSIS will be capable of 300 fps at full resolution.

But as time passes (maybe 5 years) they might drop in price to even 1/3th of that...or not...

It depends if the camera companies feel that 4K cameras are being replaced by 6K cameras in the future (by slow sells of the former), but since I don't think that will happen anytime soon. Those relatively still high prices for 4K Bayer sensor cameras will be “set in stone” for some time.

But giving the bad economic worldwide situation, I hope that I am wrong in the pricing and they will start in the **\$10K** range (especially the ones that are not “Cinema” targeted camera heads, and don't have OLPF's...but I don't think that MVC's manufactures live “under a rock” anymore, and all of them are fully aware by now what these “babies” are capable of...)

After all, the **CMOSIS 4K CMOS** sensors only cost \$1000 each.

Less than those prices? You believe in miracles? I doubt it since this 4K market is still relatively “small”, and traditionally Cinema cameras have never been this cheap...(yet).

When 6K cameras (being able to run at least 24 fps at full resolution) appear and they start affecting sales of 4K

cameras, something like what happened to the 2K camera heads might happen to the 4K ones, when most of the Professional Cinema world decided to be “future proof” with 4K resolution cameras, some 2K MVC' heads dropped to 1/3th of the original introduction price (or more in some cases). That's why you can find some 2K cameras at \$1500 now!

The Flare line of cameras is 63.5mm wide. And even if it was narrower, the lenses would still be the limiting factor here...Most of the MVC's in those resolutions have a Nikon mount lens, but as interest grows, I see them including other lens mounts as well...or use mount adapters for other lenses.

Lenses: 35mm like this ones [here](#). (use mount adapters for your favorite mount brand). I prefer the [Nikon AI-S Manual Focus](#) line.

4K Recorders:

At this time I only recommend the IO Industries DVR Express Core or the full size “Studio” Computer, recording Dual 4K/24p **Uncompressed Raw** 8 bit footage. Both options with Camera Link interface, 3 HDD's in Raid 0 per side for the Computer (they need to be with a combined minimum writing speed of 212 MB/s).

Please go to "Cinema 2K Bayer/Equipment" chapter for more details on the recorders and to see pictures of them.

The SSD's for the Express Core must have at least 212 MB/s writing speed each, or you could make a Raid 0 array with the 4 disks on the recorder, doubling the write speed of single drives.

Also a note about the IO Industries DVR Express Core with Camera Link interface, it only has **240 MB/s** bandwidth per side with Camera Link Dual Base, (in theory Camera Link Full do 640 MB/s and **Camera Link Full Plus** do **720 MB/s**. But you will need one recorder per camera for these two, check with them for more details on this). Also see the chapter about “Uncompressed Raw recording media speed and file sizes” to make your own calculations.

Dual compression on the fly for this kind of resolution is not something current computer processors can do...you will need one computer for each camera. With Camera Link Base interface. Single nor double Gig-E will do 212 MB/s bandwidth.

I will write the Full Frame 35mm Focal length comparison as “FF”.

NP=Nearest Point

FP=Farthest Point

SB=Stereo Base

m=meters

mm=millimeters

Please go to next page for the chart:

These are only "starting point" suggestions and are with the FP at infinity. If the FP is closer use a Stereo calculator instead. See the Stereo Rules chapter for more information.

CMOSIS 5.5 microns pixels

Dalsa 6 microns pixels

Format Size: 22.52mm wide

Format Size 24.57mm wide

Crop Factor vs FF 35mm: 1.598x

Crop Factor vs FF 35mm: 1.465x

Full Length Shots: (Wide Angle)

18mm lenses (FF: 28.7mm)

20mm lenses (FF: 29.3mm)

1/24.6th Rule

1/22.2th Rule

NP 3.5 m, 142mm SB

NP 3.5 m, 157mm SB

Mid Length Shots: (Normal)

24mm lenses (FF: 38.3mm)

28mm lenses (FF: 41mm)

1/32.9th Rule

1/35.2th Rule

NP 2.5 m, 75mm SB

NP 2.5 m, 71mm SB

Close Up Shots: (Mid-Telephoto)

50mm lenses (FF: 79.9mm)

55mm lenses (FF: 80.5mm)

1/68.5th Rule

1/68.5th Rule

NP 2.4 m, 35mm SB

NP 2.4 m, 35mm SB

For close ups when the FP point is closer like in indoors, you can use a wider Stereo Base.

But for outdoors with the FP at infinity, since you can not use current 4K cameras with a 35mm SB you have to use a Beam Splitter rig.

At this time, I only recommend the **Cineform FS2 4:4:4** de-Bayering that I've talked about in the "2K Cinema Bayer/ Workflow" chapter.

But when **CinemaDNG Uncompressed** will be better supported in Professional video NLE's (Non Linear Editors), export to that codec will be the best workflow.

Please if you will, first read the “Stereo Rules” chapter to have a better informed opinion on this issue.

Does 3-D works for sports coverage?

Yes if only wide angle shots were used, but since it's impractical to cover a whole event like that and close-up shots are a must, then in my opinion it doesn't.

Why do I say that, because 3-D to work correctly is governed by the “Stereo Rules”, see that chapter for a detailed explanation on this very important issue.

Telephoto lenses for 3-D work have these drawbacks:

- 1-You have to use a large Stereo Base (or Inter Axial) to have a proper 3-D effect for distant objects, and that is based on the Stereo Rules.
- 2-When zooming in and out, the Stereo Base must be adjusted accordingly. You would need a different Stereo Base for a person 5 m or 35 m away from your camera.
- 3-Working with such large Stereo Bases causes a Hyper Stereo effect, and people and objects look like miniatures.
- 4-Telephoto lenses flatten the images or compact the background with the foreground, in 3-D that looks terrible and for the most part the 3-D effect is lost.
- 5-Working with telephoto lenses people and objects appear to be a “Cardboard Cut Out” effect in 3-D.

IMAX screens are indeed the “king of the hill” in sheer size and hence they need a lot of in camera resolution to match such large film size.

But as kings are in real life, they are small in numbers in comparison to “normal” Cinema screens, less than 1% in the world.

If you still insist in working with such resolution, read below for more info.

Not long ago in the LinkedIn “Stereoscopic Professionals World Wide” group, I was discussing IMAX resolution with a member who said that he thinks that IMAX resolution would be true 12K Digital resolution. And I said this to him:

“I don't know if an IMAX 65mm film really has a true 12K resolution. It depends in what settings you scan it.

In my own experience scanning 35mm full frame film (not S35mm film that is around true 2K), I would rate it at around 3K resolution. You can scan it at higher resolutions if you want to, but it's pointless, the visual resolution won't go higher than that.

And actually in my comparisons making large prints from my Nikon D70/s cameras (3k resolution) it beats anything shot with FF 35mm film.

I have made 30x40 inches enlargements with the 6MP file and the results are actually comparable to the prints I get with a Mamiya RB67 film frame! (6x7 cms size)

I would personally rate an IMAX 15/70 frame at around true 6K resolution (9K Bayer resolution).

To be a good Stereographer, you must start from the “bottom” and learn 2-D photography techniques first. Yeah, you read that right, 2-D first and then 3-D...

In 1989 when I was 18 years old, I started doing B&W 4x5 large format film photography (developing it in my own darkroom) . Then I moved to color 35mm film the following year. In 2003 I started working with 6x7 medium format color film.

In the same year (2003) I started with “point and shoot” digital photography, then moved in 2004 to S35mm digital photography.

In 2005 I started experimenting with 3-D photography with 2 Nikon FM2 35mm film cameras. (I don't find a picture to show you my “rig”, but it was basically 2 cameras side by side in a Jasper 18” slide bar). To get good sync with the cable release was kind of difficult, but for static photography (even people) it was descent.

Then in 2006, I started doing 3-D digital photography with a couple of Nikon D70 cameras: (the sync was problematic at times) here are some pictures of my setup:





In 2009 I started using the Sony A-300 DSLR's as shown here: (the sync was better than the D70s, but not quite perfect for flash photography) The live previews on the LCD screens makes stereo picture framing easier. Also they permit a narrower Stereo Base.



I have yet to see a consumer digital camera (or even the Fuji W3) that produces relatively clean images at ISO 1600 (you don't see much noise in small screen displays) like this camera does, here an example with my beautiful **Alexander Rubio**:



This picture was taken with a 24mm FL (36mm in FF 35mm) and with a $1/30^{\text{th}}$ Rule approximately.

You can see more 3-D pictures that involve my other “passion” as well, that is flying! (you need a stereo viewer like [these](#) to see the 3-D effect, the Pokescope is my favorite so far..)

[Oshkosh EAA AirVenture 2008](#)

After you have mastered 2-D & 3-D photography, then move to 3-D video that is a little bit more changelings!

This is how a good Stereographer starts...seeing his/her first 3-D images, and LOVE Them!

I started loving 3-D photos, when I saw my first 3-D View-Master reel when I was 7 years old, back in 1978.

Here my beloved David Rubio enjoying 3-D!



And here having "3-D withdrawal" symptoms, just like me when I could not get my hands in a View-master, I would invent just anything comparable, I even made one with cardboard and draw my own "reels"...;-)



Both of my two beautiful sons, **David and Alexander Rubio** (D&A Rubio) love 3-D movie in the Cinema and at home.

They both started watching [Field-Sequential 3-D DVD's](#) since they were very little.

Now they have a proper [3-D HDTV](#) where they watch newer [Bluray 3-D](#) discs!

I've just found a post I made on September 9th of 2006 on the [Yahoo 3DTV Group](http://movies.groups.yahoo.com/group/3dtv/), I said this:

“I hope to get this to work with out damaging something...but anyways, all discoveries and inventions are with some sort of sacrifice.”

<http://movies.groups.yahoo.com/group/3dtv/message/13790>

Oh boy, sometimes I hate to be right!

These past 5 years I have had to sacrifice many things in pursue of my 3-D project...

But I hope that at the end it will be worth it.

3-D Conversions have their right place in a stereoscopic production, is another tool for the craft.

For example there are moments in time that can not be replicated again, and that originally were captured in 2-D.

Precious pictures or movies, that we love and cherish for a lifetime.

Like this picture of my beloved **David Rubio!**



I took this 2-D picture in the summer of 2006, and I love it!

It was the original forum banner picture of www.davidrubio3d.com (now archived only)

[Here](#) you can still see how the website looked in early 2007, just a few weeks after I started it. (That Way Back Machine is amazing! Just like traveling to the past...)

This extraordinary conversion was made by [William 3-D](#).

Here is the Anaglyph version:



And the side by side version:



I know now that this may never happen in this current system of things, but I will include it in this book for “historical purposes”, and because I know that this might happen in the new world.

Note: This is an edited version of the original; I will include the letter “E” (Edit) for current December 2011 edits, for small orthography edits I will not make any annotations.

I posted this on the **Yahoo 3DTV group** on March 3rd, 2009: (I only changed a couple of links as well because the originals are broken now).

Here you can see the complete discussion:

<http://movies.groups.yahoo.com/group/3dtv/message/19799>

Ok here it goes my next great idea, or dream I should say...(besides using MVC's for 3-D Cinema of course)

I know that many important people that work in the Hollywood Cinema Industry read this group. (E:or will read this book)

I've been thinking that with the current global economic crisis (E: nothing's change in the positive direction since then or things are even worse...)...the expensive cost of digital projection has made most cinema owners "think twice" about switching to digital (or halt that endeavor at all). E: For this very reason, many even do S35mm film projection with 4K digitally captured movies.

And that is just for one single 2-D projector...double or triple the cost for a 3-D Cinema projection set-up.

We already know that 3-D movies make more \$\$\$ at the box office than the 2-D version. (E: still true)

If we instead of going BIG, go smaller, lets say 720p resolution (E: now 1080p projectors are also affordable in “home” viewing projection throw distances and brightness) for a 4/E: 6 mts wide 3-D screen (for 56 people or so) with more affordable projectors like this one here:

E: These projector is for the use of two for 3-D, like IMAX 3-D projection does.

http://www.bhphotovideo.com/c/product/518329-REG/Panasonic_PT_DW5100U_PT_DW5100U_WXGA_1280_x.html#specifications

E: Also there are appearing single 3-D 720p/1080p “home” projectors on the market now a days...

Think about it, there are many small cities (like where I live with less than 10,000 people) that a RealD, Dolby 3-D or IMAX 3-D cinema would not make any sense for the deployment costs...hence there are none of those 3-D Cinemas in such places. E: A better choice now is the use of **Master Image** projection system for single BIG 3-D Cinema projection .

In Mexico there are only 7 Real-D cinemas, in Guadalajara (where I was born) even though is the second largest city in Mexico (comparable to Chicago)...there are NONE 3-D Cinemas! (E: now they are a few)

Now see the BIG PICTURE (Entire World)...the cake is TOO BIG for one company or for a few people...

I for once would love to be a cinema owner of a such Small Venue 3-D Cinema...

But we need the help from Hollywood and the Studios.....

Current movies are shot at 24 fps, Christie, Barco and other LARGE venue Cinema projectors can do that...even 144 fps for Real-D systems.

But not the "prosumer" ones that can do only 60hz.....

We would need the Studios to release E: 720/30p or 1080/30p (each side) versions of the movies for such small 3-D Cinemas.

E: Also the use of inexpensive workstation "server" would be ideal.

I know that nothing of that would be DCI "complaint", and new anti piracy methods would have to be invented for such small Cinema systems.

But I think that the Studios would make MORE money for the LARGER penetration of their 3-D movies....

One of my dreams and that's why I started our 3-D forum, is to make 3-D accessible for most people in the world...especially the poor like me:

http://web.archive.org/web/20090123140521/http://davidrubio3d.com/view_topic.php?id=29&forum_id=38

I know that powerful "interests" of some companies would see this as a threat, but it is not.

They would still have the largest cities in the world, while many, many of us and I am talking of almost anyone who loves 3-D, would have access to be a small 3-D Cinema owner!

56 seats are not bad....I have gone to see 3-D movies where I was the only one in the Cinema...and 300 empty seats!

With almost One 3-D movie release every two months this year, and one every month for 2010...and more for the next years, that's an extraordinary opportunity to have a 3-D only small Cinema! (E: 2012-2013 will see a significant increase of 3-D movie releases)

Also past 3-D movie releases would be accessible as a "discount movie ticket" like there are still a few 2-D cinemas like that around. (\$2-3 dills the tickets)

I know that Bluray and 3D-HDTV is the next big thing (E: Nothing really great has happened there for the small availability of content)...but there will be always poor places in the world that they would never have \$2-3K USD to spend in such systems.

Poor people are like anybody else...they also love entertainment...and we the ones that are in a "better" position should not denied them that!

I've been keeping this "secret" to my self for some time now, but I think that is time to make it public...no matter what the consequences will be. (E: People started following me short after I published this post on the Yahoo Group and on my forum...so I think it did have consequences...)

I am sure that even if I am not around to see this dream come true, my sons would be there to see it, and rip the benefits of their poor "dreamer" PA-PA.

What do you guys think?

Would the Hollywood Studios cooperate with the poor? (E: Do you still believe in fairy tales...because I stopped doing that already...for the time being)

Thanks,

Cesar Rubio.
Cambridge Wisconsin, USA.

A **December 17th 2011** after word on this:

Recently in the “**Stereoscopic 3-D Professionals Worldwide**” Linked in group (who's owner is an excellent Stereographer and a dear friend of mine, [Alexander Lentjes](#)) I proposed that movie tickets should cost the local minimum hourly wage.

And that the costumer (the audience) should be offered the choice of purchasing the 3-D glasses (like Real-D and Master Image already do) and the cost of such should not be more than \$2 USD, they do that already too for the most part...but also when buying the 3-D movie ticket, if they already bought glasses for that kind of projection, to be able to use previous purchased ones if they want to instead of having to buy new ones every time.

I think in some parts in Europe they already have that choice, here in the USA AFAIK, this is not possible yet...but “savvy” people might just buy the 2-D movie version ticket, get into the 3-D movie Cinema and use previous purchased 3-D glasses...I have not done that yet. It just crossed my mind...

Also for the minimum wage ticket price proposal, some found it interesting...and others not so much of course.

But it's ironic that right here in the “center” or the Cinema “Mecca” of the world, in the very heart of Hollywood (actually Burbank CA is the where most productions are made) you can buy 2-D movie ticket for \$1.50 USD!

Here in California the hourly minimum wage is \$8/hr.

$$8/1.5=5.3$$

More than five times less the price that I proposed! Wow.

I wonder if we apply such “rule” to the entire world, how much tickets should cost then? Think about it, and doing so you may think about how great Global economic disparities are...and hence, injustices...

Why so cheap? To try to drive people to the Cinemas again. To fill all those empty seats.

Why some people don't go to Cinemas today? Maybe because many people are losing their jobs, houses, cars, credit, even in some cases spouses and in extreme cases self respect in the way too?

Most people don't have enough money for even a “day to day” basic expenses here in California that it was supposedly at one time the “7th Economy” in the world if it was an independent county...

Whom that is hungry will think to go to watch a movie with the stomach empty?

Here at the corner where I live here in Los Angeles you can rent movies as cheap as \$1 DLL, DVD or Bluray don't matter. New or old releases. I asked then why so cheap rentals? They do that or they would go bankrupt...and with the “volume” of \$1 rentals they can stay “afloat”.

And even the ones that are in better economic position to go to the Cinema, may just buy a large screen HDTV or

projector (2-D or 3-D) and stay in the comfort of their homes instead of spending crazy prices like \$18 for a 3-D movie ticket!

If that's is happening here in the "richest" country in the world...how must be in the rest of the world?

Do you think that my "Small Venue" Cinema (2-D or 3-D) makes sense now?

Well it seems it does, since here not too far away also exist the "cheap movies" where people only pay \$3.5 per movie ticket (\$2 extra for the 3-D glasses)...and the Cinemas are really small. There is where I saw the Master Image projection 3-D system for the first time, not too long ago...

Taking all that into account, this is my proposal for a portable camera system for Live Action 3-D productions:

Dual Camera Heads + DVR

Brand: Open

Model: D&A R-3D

Specifications:

Camera Heads:

-30mm wide (or 20mm if possible, depending on the mid-telephoto lens diameter as well)

-Sensor:

-CCD or CMOS with Global Shutter

-Diagonal layout of “photosites” or pixels, just like in the sensor on the Sony F65 Cinema camera

-5.5um (microns) pixel size

-Do I have to tell you to put an OLPF (Optical Low Pass Filter) on top of the sensor? Well, I already say it anyways :-)

-2/3” format size

-Resolution and Frame Rate: CMOS: 4K/1-60p (4096 x 2160 1 to 60 fps). Optional 61-360 fps to external recorder for slow-mo (depending on camera interface), even by “windowing” the sensor and outputting less resolution like 2K is fine for such short effects.

Going with CCD, 4K/24p it's fine.

-Color Depth: 8, 12 bit and maybe 16 bit Bayer.

-Sensitivity: ISO/ASA 1280 at 0dB (preferably with “clean” ISO 2560/5120 as well, 6dB & 12dB gain respectively)

-Dynamic Range (DR): 60 dB+ (but the goal for now is to match at least film negatives)

-Camera Interface: Camera Link (full), CoaxPress, Firewire 3200, USB-3, 3G-SDI, Fibre Channel, Thunderbolt or other even faster interfaces that shows up in the future.

Lenses:

-2/3” C-mount

-Resolving power: 5-10MP

-33mm in diameter max tops. This is especially important with the mid-telephoto lenses.

-f1.4-f16

-Manual Focus

-Focal Lengths: 8/8.5mm, 12.5 and 16mm.

Digital Video Recorder: (DVR)

-Dimensions based on the screen size and current capabilities...

-Display: Touch screen 7" diagonal (ideal target size, but if the recording "body" must be bigger at the beginning, then make the screen size accordingly to such size)

-Display Resolution: At least 1280 x 720 pxs, but 1080p/2K would be the ideal target.

Color display 8 bit.

-**Uncompressed Raw** (8, 12 and maybe 16 bit recording modes) preferably with **Cineform Raw Uncompressed** or **CinemaDGN Uncompressed** format.

-Stereo Audio Recording (with level control) input/output, just in case some prefer to record the audio in sync with the video right away in the same recorder. Most will record better more detailed sound externally (more channels) and sync audio/video in post. But having options is always better.

Recording Media:

-Dual SSD's (Solid State Disks)-SLC (Single Level Cell)

DVR Software:

-Start-Stop Recording/Playback modes

-Option for a continuous recording mode in the same files

-Raw display mode (Black & White), Color mode if the CPU-GPU power permits it, for quick WB and Gamma setting preview and finer adjustment...I know since its Raw we don't "need that", but setting those targets before recording is better, than extremely manipulate them in post.

Also display modes, side by side, individual side with digital zoom focusing aid. Maybe with optional Anaglyph mode. For me, I don't need it. And it needs more CPU/GPU power to make the "3-D" on the "fly".

-White Balance: Auto, 3200K, 5600K.

-Gamma: Custom (via color remapping or the one set by camera manufacturers like AVT does in their cameras, the "middle" setting is always a good starting point to further manipulate the gamma curves in post).

-Gain Control: -18-0+18 dB (with a "clean" 0dB)

-Shutter Speed: 1/48th, 1/24th, 1/50th, 1/25th, 1/60th, 1/30th, and Custom

-AOI/ROI (Area/Region of Interest) for custom resolution and aspect ratios

-Custom frame rates

- Color depth choices of Raw 8,12 and 16 bit Bayer

- Time stamp frame (time code)

- Image Flip (when using Beam Splitters for macro work)

- Audio recording monitoring

- Full de-Bayering/demosaicing/ export adjustments/options in the editing computer software (separate from the recorder), with CinemaDNG, Uncompressed RGB (AVI or MOV) and other video compression codecs exports (when available in editing computer)

But even better than this, having “native” Raw support in Professional 3-D video NLE's...like when recording with CinemaDNG.

And a little bit of everything just like a good “buddies” chat should be to make it more “interesting”...sorry I have the right of free speech don't I?

You have the right of not reading this as well...

And this is maybe a good “paper” for my therapists, for them to find clues into why I became “crazy”...:-)

Even if you have read this on my blogs before (who has the patience now a days for a 7000 words post?), You might want to re-read it again (yes more work, but that's real life...a lot of hard work) I have made slight corrections here.

First off, I want to start by explaining what is [Machine Vision](#). According to Wikipedia, “is the process of applying a range of technologies and methods...”(for a certain given application)

Someone in the same Wikipedia article wrote this:

“machine vision is not an industry per se” but rather “the integration of technologies and products that provide services or applications that benefit true industries...” Me: Like 3-D Cinema for example? :-)

(Update note: That info was changed after I posted this info on my blogs...that's the bad thing of Wikipedia, that some people change certain important things all the time, (especially the ones that don't go with their “ideology”)

So this project is based in Machine Vision Cameras (MVC's), but to make it more “human” and “accepted” as the “new kid in the block”, let's remove the “machine” term out of the equation and leave it only at “Vision Cameras” please...

For 3-D Cinematography, a proper name for this system would be:

Vision Stereo 3-D Cinema Camera System.

[Steve Jobs](#) said at the [Stanford University commencement speech](#) in 2005, that is “easy to connect the dots looking backwards...but not so easy looking into the future”.

Having said that, I am not God and cannot exactly view what technology advancements will be available a hundred years from now regarding 3-D Cinema capture....less a thousand years from today.

This proposed 3-D system is something with technology that is already available now, is just putting the “puzzle” together or “connecting the dots”...

I will “wander” a little bit at first, but I think it's necessary to get to the final point. Sometimes to explain something fully in detail, you need to have and present all the facts into account...just like a good story needs to be told in a movie to be understandable by the viewers that are not familiar with it already...

And also you might learn a “thing or two” about Digital Photography as well. I wish I had the same “luck” when I started in Photography, but no almost anybody would share anything they knew with me because they were not very “fond” with competitors...so I had to learn Photography reading books and practicing it myself (I even had a B&W -Black and White- darkroom to develop my own work).

I am fully aware what the “Pro” term means in the industry, I started my professional career with [Large Format Photography](#) back in 1989. So if sheer resolution was the only most important thing in an image, almost nothing would beat this format. Imagine how many [Bayer](#) “Mega Pixels” (MP) you would potentially extract of an 8x10” (inches) sensor size!

(And even that format size is still “small” in comparison to other 20x24” and to “infinity and beyond” 48x48” or larger negative formats sizes!)

But let’s keep it “civilized” with a 8x10” sensor size, to be able to “comprehend” the numbers better without needing an “[Albert Einstein](#)” kind of level of intelligence :-)

So a 8x10 digital sensor (with 5.5 um pixels size) It would have like 46181 x 36945 pxs or a 1706 MP frame resolution!

Something like a 30K true resolution out of the 45K Bayer (with a good quality-slow debayer or “[demosaicing](#)” of course).

But in a direct 8x10” film scan, you would get like 21K true resolution (having into account that a S35mm frame, “24mm” wide is a true 2K resolution one....yeah I know, I know some guys say that such frame is 4K but I don't think so buddies!)

I have scanned FF 35mm (Full Frame “36mm wide”) negatives, and I would rate them at 3K true resolution. And I am being very “generous” with such rating, as a 3K Bayer resolution (2k true resolution) will beat the such scan in real life results!

Yes, I can get more resolution from a 3K Bayer sensor camera like the [Nikon D70](#) (6 MP), than with a FF 35mm scan! Don't believe me? Make your own tests, and then comeback to tell me that I am wrong please...

I have done beautiful 20x30” photo enlargement with such 6 MP files, that almost rival a 6x7 cms Medium Format negative in quality! (made with the [Mamiya RB/Z-67](#) camera).

With a FF 35mm negative, the most quality you can get with out showing lots of grain and losing detail in the final print, is a 16x20” enlargement. Forget about making a 20x24” print out of such film size...that's why “good-old” Professional Photographers, used (and some still do) Medium Format film cameras for such enlargement sizes and beyond...

If “more” resolution would be the “best” way to go, then all photographers would still be using Large Format cameras...imagine a modern wedding or photojournalist photographer (they did that in the past) using such cameras today! ;-)

In 2005 a photo lab rep told me that the Nikon D70 DSLR was not a “Pro” camera, since it was only a 6 MP cam, that you would need at least a 10 MP camera like the Nikon D200 to be really a “Pro”...I would love to hear again his statement today, if he still considers 10 MP “Pro” resolution...LOL

BTW, I owned the Nikon D200 later on too, but used it very little and then sold it...(also bought the D80 “same sensor as the D200” and even the D300/D90 12 MP cameras, but returned all of them shortly after making some tests with them...) They didn't “make it” in other important “departments” like flash sync for the D200/80 and high ISO for the D300/D90) The D70 and [Nikon D700](#) will beat them in those regards easily.

One DSLR that I really liked was the [Fuji S5 Pro](#), beautiful DR (Dynamic Range) almost like film, but slow in Raw capture, it was useless for fast paced wedding photography. Returned it too...so I probably have a “record” of some kind with all my “experiments”...at least returning cameras! ;-)

I am still using the D70s camera, that's a “keeper” in my book, and is actually the best camera ever made (film or digital) for flash synchronization at all speeds (1/8000th tops). Wedding photographers would almost “sell an arm and a leg” to own a complete Hasselblad camera kit that could flash sync at 1/500th. Even the [Nikon D40](#) can flash sync at 1/4000th. (the D700 in DX mode does 1/500th)

And please don't tell me about “rear curtain flash sync” mode with some DSLR's, It's useless for anything that moves. I've already discussed that fully in internet forums with “hardcore” Pros...It's tiresome to discuss certain things with some “fan-boys”...they will blindly see what they want to see, and almost nothing will make them change...

Here are some examples:

[Nikon D70 Flash Sync 1](#) (probably you won't see them with this link, I don't know that for sure, since I don't have internet access now to check it out)

And some more additional pics using a Tamron 17-50mm f2.8 lens and using a Lumedyne flash kit as well:

(These pictures are not edited, just grabbed them like they were out of camera)

[Nikon D70 Flash Sync 2](#)

If you think “that's nothing” a “piece of cake”, think twice! Study the Exif information in the pics, sorry the first ones since I used a Manual Focus Nikon 50mm f1.2 lens, it doesn't show the lens aperture...another thing that the D70s would need to be a “truly” Pro cam, would be the ability to program manual lenses to exhibit lens aperture info. Like the D700 can do.

Love out of focus background in 2-D photography? Who doesn't?

Then a wide lens aperture is called for. From f1.2 to f2.8, and at least a 50mm lens in the S35mm format would do it. You could use longer lenses too, but try to use “fill flash” at above 3 mts/10 feet from your subject...

In order to use wide lens apertures in daylight, you have to lower your ISO, the Nikon D70s only goes down to ISO 200 (I would love at least ISO 50), and to get descent exposures you will need higher shutter speeds...or the use of Neutral Density (ND) filters, but for flash photography it doesn't really matter what you choose, you will have to increase flash power with either in the same way.

The more higher shutter speed you use, the more flash power you would need (and fastest “pop” duration of it), the same for ND filters, the darker they are, the more flash output you will need.

Anyways, try to flash sync with your camera at 1/4000th, or any other like 1/2000th or even 1/1600th...then if you can do that, throw in a polarizer filter in front of the lens to get much richer saturation and sky color rendition. More flash power you will need.

And to make the look less “harsh” in people photography, add a diffuser on the flash head, to soften the light...more flash power you would need!

Now step back at 3 mts/10 ft from your subject, by then you'll be screaming: I need more flash power please!

Then take 20 consecutive pictures...if your flash can recycle fast enough for that kind of output power, and you don't “burn it” in the process, congratulations you have a “top of the line” or “High End” Pro flash equipment!

Can't beat [Lumedyne](#)!

The [Sunpak 383](#) is also a “workhorse” flash, manual and reliable, after I used it the first time, I never used any other flash ever again for most of my work (I started using the Lumedyne later in 09'), a \$80 USD flash that will beat other flashes costing hundreds more...including the expensive Nikon line.

I would love to see the return of such flash one day...it's a “classic” and a “keeper” as well. Thanks God I still have

3 of them!

You don't need “dedicated” flashes, and even though the 383 does have an “auto” mode too, I never used it....learn basic Photography and lighting, is cheaper than buying “auto” everything and you'll be surprised of the control you can have over the final images. That's why you won't see “auto” anything regarding Cinematography. They are Pros not “hobbyists”.

Why I include this here? Because all is connected, Photography and Cinematography, why do you think the term “DP” exists in Cinema? Because that's what they are, Directors of Photography!

Learning 2-D is also very helpful for 3-D capture as well, as the same principles apply for both, and although they go sometimes in “different directions”, like a deeper DOF (Depth of Field) is more desirable in 3-D, you still need to know both fields pretty well to get the best out of each one.

Regarding resolution in photography, with a 6 MP camera like the D40, is almost all the resolution you need for 99% of photo applications, don't believe me, go ask [Ken Rockwell](#).

The only thing to really make an indeed truly Pro camera out of the Nikon D70/s, is if it did Uncompressed Raw capture, the D70 only does like 1.7:1 compression (Nikon Electronic Format, is the term they use for Raw).

I also owned the Nikon D700, love that cam too. I always used it in the “DX crop” mode to get better focus and deeper DOF at f2.8 constant zoom lens aperture.

It gave me around 5 MP files (2784 x 1848 pxs) but I would care less, they were what I needed it for most of my work. I only bought that camera for the relatively clean ISO 1600 shots (the D70 only do ISO 400 tops) that produces with available light in interiors to avoid the use of flash. (natural light gives better looking images, almost “3-D” like, while flash “flattens” them and produce horrible “dark cave” effects in low lighted backgrounds)

I am kind of “crazy”, I prefer available light (no flash) photography in interiors, while in exteriors I prefer the use of flash photography, as a “fill light” in direct sunshine to avoid the “raccoon” effect in people faces, and when taking the pictures in a shadow like under a tree for example, the flash will permit me to get a well exposed background, that otherwise it would be overexposed if I did not use flash to compensate the exposure.

I would really like to see the “return” of a 6 MP Uncompressed Raw camera with an “hybrid electronic/mechanical shutter” like the Nikon D70/s camera, and with today's sensor technology, a clean ISO 6400 output would not be hard to achieve either (something like ISO 25,600 tops without the “extended” ISO modes that are worthless for the most part).

Actually MVC's with ["Global Shutters"](#) sensors (like CCD's and a handful of CMOS), not needing a mechanical shutter, could permit high flash sync as well. Those MVC's are good for everything regarding digital image capture!

At this point in my life, like Mr. Jobs once was too, I am out, very publicly out of the game, hungry and “foolish”....But at the same time I fell free like never before in my life, I don't have a boss that can “fire” me, nor any business relationship with any camera manufacturer that I could put in “risk” as a dealer of their cameras...

A few years ago, a camera company from the other side of the world asked me for my input in a 3-D video camera design, I did not respond back then, because one of the previous statements I already mentioned (and others that I won't discuss here as well...).

So here it goes for the whole world to see. My 2 Mexican pesos in the subject:

This is what I want in a **Vision Stereo 3-D Cinema** camera system:

If I did it myself, I would call it **D&A R 3-D**, so please if you are going to “rob” my idea or parts of it, at least consider name it like this at some point. It would be to honor my “memory” and hard work on the subject...all those thousands of dollars and hours spent in gear and tests, and more over in “real life” experience in 2-D photography (film & digital), and video.

And the most important in this case, 3-D work, that although I still feel that I have limited experience with it, and “miles to go” yet in this regard. I think I already have the “basics” figured out pretty well for stereo. But by no means I consider my self an “expert” in the field, when you do that you stop learning thinking that you know everything already...the worst mistake anyone can make in their professional career.

But that statement doesn't mean that I would do “toe-in” because “famous Joe or Jane ” does it and swears by it. It's their own decision to do whatever they want with their work. Same for what I write here or have written in the past, take what ever you think it's beneficial for you and your particular way of doing things, and throw the rest aside...just ignore what you don't like. Not big deal!

All those past 22 years work experience is what “makes me” now , and what I know today. That's why “consulting” is not cheap. It cost time and effort to be a good consultant in a field you can “master” correctly.

But mainly, the **D&A R 3-D** name, would be a gift for my two beautiful sons that are the humans beings I love the most in my life, **David & Alexander Rubio**.

All of my most important and significant work “legacy” and achievements, I would pass into them so they can continue with my work when I am gone...

These are the Specifications:

-Two separate camera heads ...This would be to be able to change Stereo Base (SB) or “Inter-axial” in a Stereo “slide bar” like the [Jasper's](#) that are beautifully crafted BTW.

-Heads size: 30mm (wide) tops to permit that SB, and the use of 30mm lenses or less in diameter to be able to manual focus them easily (especially the mid-telephoto ones)

-2/3 format size (around 11.2mm wide) with 4K resolution like the [Sony F65 sensor](#). Why this sensor design and resolution?

Because it would permit such resolution with 5.5 micron pixels size. Want Global Shutter in a CMOS sensor, among other benefits like higher “clean” ISO/ASA at 0dB and also avoid lens diffraction? Then 5.5um is the “Pro” pixel size (now a days).

Some sensor manufacturers rightly point out, if you can really get “double” the output resolution with such sensor design as found in the F65 vs. a traditional Bayer sensor design...

BTW, I would personally call that sensor design as Bayer X2 or Bayer+ (like some famous social network that is putting into a “corner” and threatening the “leadership” of another older one...)

History repeats itself every single time, new things comes and replace old ones all the time...

So we have to wait for “real life” resolution tests with such sensors, made by a third party tester (never trust camera manufacturers claimed specs as they almost always “inflate” them to be ahead of competitors...at least on “paper”)

In any case, if it indeed gives 4K Bayer resolution, or even 3K, I am “ok” with both as we only need 3K Bayer for a 2K cinema distribution finish. Down-sampling 4K to 2K gives even finer detail than 3K to 2K, so this would be actually more beneficial for large screens projection.

And please don't tell me that we need a 4K finish (6K capture from Bayer cameras) to be “future proof” for Cinema, true 2K is good enough for 35 feet wide screens, and since projecting dual images as in 3-D Cinema, we actually “up-rising” the resolution like 1.5 times more, so I can safely say that we can use 2K 3-D projection up to 50 feet wide screens.

Some have even used 1080p true capture resolution -3 sensors- cameras in giant IMAX 3-D screens. Like “Ghost of the Abyss 3-D”, U2-3D and Avatar 3-D movies, the latest I saw it in a really huge screen and I did not notice that it was only “1080p” resolution...nor anyone else complained about that either AFAIK.

Also the possible use of higher frame rates at capture like 48fps and 60fps increases the “perceived” resolution even further when projecting them, and also such higher frame rates would get rid of the “triple flash” that is used today in 3-D Cinemas (like [Real-D](#) and Master Image projection systems)...that causes some people eye strain and makes them cry...really, I've seen that! (with Real-D)

Most of the world's Cinemas haven't even changed to 2K digital Cinema projectors because of the cost of them, some small venues cannot make financial sense with such large initial investments (in the 100K USD price point or more...) and then the costs of the also expensive projector lamps in the long run. No wonder the majority of the world's Cinemas still uses “good-old” film projectors! (even to project Digital captured 4K movies) Because they are cheaper and reliable. A hard to beat “work-horse”...

The most powerful digital single 3-D projectors today can only handle 2k/60p streams tops. And they cost a mini-fortune! So still for some time to come, 2K projection is not going anywhere anytime soon...nor the “world has moved on from 2K” like some people claim...No way Jose!

The world has been “content” with 2K true resolution since the invention of [S35mm](#) for [Silent Film](#) back in 1892.

I don't even think that the 2-D Cinema world will move to higher frame rates! Most people love the “feel” of 24 fps. And anything higher they will compare it to a “soap operas” look and feel...

Higher frame rates are indeed desirable and beneficial for 3-D projection, but for 2-D Cinema is something we still need to see if the world will embrace it or not...

Also most of the experts in the field, agree that is time to move on from 24fps to 48fps or 60 fps for 3D Cinema. But please see the “Uncompressed Raw recording media speed and file sizes” and the “2K Cinema” chapter before you make your final decision. Then even do some tests first to see if you like the “look and feel” of higher frame rates or not. Ask “civilians” what they think of the look too...

Need [IMAX](#) resolution? Then get a a 6K true (9k Bayer) resolution camera...there are not projectors capable of such resolutions yet. But since the largest IMAX digital screen is about 100 feet wide, for 3D projection we might be “ok” with true 4K projection (out of a 6K Bayer sensor camera) The Sony F65 is the only camera as of today, that could potentially be able to handle proper true 4K footage for IMAX 3-D screens without “sweating blood”...

The DCI ([Digital Cinema Initiatives](#)) calls for 4k/24p projection, and there are already some of those 3D projectors in the market today, but with the moderate “brightness” they offer in 3-D mode, the projected screen size can not be very large, so the best way to get more bright 3-D images in such large screens, is still the use of 2 separate projectors like IMAX does for their screens.

The upcoming Laser Projectors will solve the lack of brightens (or darkness problem I should say) in 3D projection, and they will solve another 3-D projection problem (the “flicker” caused by double or triple “flashing”) with the use of “passive 3-D projection” as well ...Great! Less headaches and discomfort watching 3-D (with proper shot and edited stereoscopic content that is...)

But I am not sure if they will “rob” resolution like most Passive 3-D systems do, probably yes. I haven't

investigated the subject thoroughly yet since there is not much info on the internet about them, other than that they are brighter and they are “coming”...but when? It might be like Armageddon, we know it's coming too but we don't know when exactly!

I would prefer 2k/48p 3-D than 4k/24p 3-D anytime, and since 2K projectors account for most of the projectors installed in the world right now (especially 3-D capable, read more of this on the “24fps vs 48 or 60 fps” chapter), you don't need to be a “rocket scientist” to figure out the capture-finish resolution you want/need for 3-D! :-)

And what about delivery for Quad-HDTV's? (3840×2160 pxs) Yes sure, you can buy one of those TV's probably as early as next year sometime, but you will have to wait a long time before seeing any 3-D broadcast's in that resolution...or even 2-D footage for that matter!

Some 3-D experts are comparing the current HDTV (High Definition Television) transition from 2-D to 3-D, as the 25 years it took from SD (Standard Definition) TV B&W to Color!

Current High Definition broadcasting's are only 1080p (25 or 30 fps) and 720p (50 or 60 fps), forget about the 1080i (interlaced) 50 & 60 fields per second, 3-D looks much better when captured and displayed in progressive mode. And it's not even so easy to transmit two 1080p or 720p streams for 3-D in current networks infrastructure, that's why the MVC ([Multiview Video Coding](#)) format was invented for HD broadcast pipe lines. (and Blu-ray 3-D delivery as well) A better “workaround for this IMO would be to send two 720/25-30p streams over the 720/50-60 current infrastructures...but that would lower the resolution when watched in 1080p displays.

You will probably see first 1080/50-60p (2-D/3-D) broadcasting's, and later on maybe Dual-HD (2880 x 1620 pxs), before Quad-HD!

And besides all that, who needs Quad-HD resolution in a TV? (2-D or 3-D don't matter) Only people who sit 30 cms. or 12 inches away from the screen probably! ;-)

But that brings another “unexpected” problem too, people would have to move their heads like crazy all the time to follow action and “scan” everything in a 130” (diagonal inches) screen size at such short viewing distance...LOL

That is the main “point” for more resolution correct? The use of larger TV panels...65” TV's most “experts” say is “ok” “up to” 1080p res...more than that and you will have “problems with resolution”...

Why bother even with a big 130” TV BTW, when you can get beautiful 130” projections with a 720p projector? (Sitting from a more realistic distance, in most houses).

Projectors are cheaper and smaller than TV's...but that's another “secret” that TV dealers don't want you to know about...how many digital projectors you see on and “running” at your local electronics store? Not many, and if they even show some of them, they will be at the “back” of the store, and how many HDTV's are on and working in “the main people traffic spots” for you to see first? Lots of them.

Why they do that? Simple, they make more money selling you a \$3K (USD) HDTV than a \$1K Projector. Pure and simple marketing strategies to get the most money out of your pocket....Capitalism at it's best.

[Ultra HD TV's](#)? -7680 × 4320 pxs- (four times larger than Quad-HD or 16 times larger than HD), come on guys, you are kidding right????!!

I think that the guys who even “invented” that term for TV, watched too much cartoons while they were growing up and love [Sci-Fi movies](#) at it's extremes! :-)

They even say in the Wikipedia page that Ultra HD is IMAX resolution, I would say is even beyond that! As I have already said that I consider IMAX at being 6K true resolution.

Do you have a room in your house the size of an IMAX digital theater screen? Or even 1/4th of that (around 25 feet wide) to be able to use an UHD home version projector? Or perhaps room for a 260" TV size? (That calculation is based on the statement that 1080p is good up to 65" TVs')

If not, then you don't need it. Period.

Oh boy, one thing leads to the other and it's very easy to get "lost" in all this mess, but believe it or not, all is carefully "orchestrated" by corporations to make billions of dollars out of the working poor man's hard earned money!

Trough a carefully designed life time "upgrades" increments plan. They know that people gets "tired" of the "same-old" stuff...yeah they know that people weakness very well and exploit that for their financial advantage! (All those plans are the "road map" in companies, and will release them when they feel it's "time" to move on...)

If you really want to be "future proof, go shoot and edit beautiful Stereo 3-D, even at 3K/1080p Bayer capture for a 2K/720p finish, and I can warranty you that if it's good work and with a good story (story is always king in productions) your work might last for an eternity!

Back to topic please. Ok, I "Roger" that, sorry! :-)

Format Size- 2/3"

In a traditional Bayer sensor, to get 3K resolution with 5.5 um pixel size, we would need a 4/3" sensor size (approximately 18mm wide), but I prefer the 2/3" format for stereo because it gives better DOF ([Depth of Field](#)) in interiors with available light, when using wide lens apertures like f1.4 for example.

ISO/ASA at 0dB- At least 1280, but higher clean "gain" of 2560/5120 would be "it" for 99% of available light work to get a deeper DOF in 3-D.

-Frame Rates: 24-60 fps, but it would be "sweet" to get even short "bursts" of 300 fps for cool slow-mo 3-D! Without "windowing" the sensor in doing so of course, because that will lower resolution as well. Also this is subject to camera/recorder interface and recorder capabilities.

-The fabrication of a really small "Beam Splitter"(BS) rig (or "Mirror Rig") to handle tight close-ups and macro Stereo work. Something that it could handle lower than a 30mm Stereo Base...it would be the world's smallest BS rig! Are you in the biz of making mirror rigs? Hurry up an be the #1 making it! It seems everybody enjoys being the "first" in anything, so there you go, I will concede you "passing me", and get the "glory" for yourself! ;-)

And rightfully so, when people are the pioneers in something, they risk a potentially failure as well, it takes courage to travel in unknown "waters"...they do the hard work, while others play it "safe" in the background, watching them from a distance, and if the "leaders" are successful, then the rest of "followers" will "jump on board" too. Everyone wants to be "friends" with successful people, but with the ones that failed?

Do you know that before each "success" there were many failures? It is very rare when people "get it right" the first time...it takes years of experience and trying without given up, what makes a final successful people. That's why I have this phrase as my signature in some forums:

"It's the long term experience of problem solving that makes you successful!"

I read it in a Professionals Photographers magazine in 05', don't remember now who said it though, but it made me think, and that guy was right!

The Recorder: A small "tablet computer" touch screen device, that would also serve as a display. If you want to go

really small, a 7" wide screen size would be "ok" as long as it can display side by side, each side individually (with digital "zoom" for precise focusing aid) and also "auto-stereoscopic" mode would be "cool" and "perfect" for some that need such thing. For me, I don't. If you really know what you are doing, you don't need to "preview" the 3-D effect.

Applying stereo rules like the 1/50th-1/60th rules for example, for the Nearest Point or object in the frame, is all that you need to "nail it" or "get it right".

That is comparable to hardcore Pro film Photographers and Cinematographers that do not need a "live preview" either, to get the shots perfectly exposed and framed. That's why "exposure meters" and optical viewfinders were invented for 2-D film Photography and Cinematography.

The use of Stereo Base Calculators has its place, but you have to learn how to calculate distances without a tape measure for a faster workflow.

Even for the nearest object, you would not be using a "tape measure" every time correct? I learned to mentally calculate distances with manual flash Photography and using prime lenses. It takes skill and dedication, but once you are good at it, you will run in "auto" mode at an incredible fast pace!

Wedding Photography is one of the hardest business, and try it with manual flash, manual cameras, changing prime lenses all the time (at least 3 Focal Lengths) and rolls of film in the middle of important action...and then taking video at the same time (changing tapes every hour of footage too) for 12-14 hours straight....a "one man band" thing...Try it!

You will be in bed for the next couple of days sore and tired, but it's a satisfaction that very few people can feel in life. I've done it lots of times...when people saw me working they would be amazed on how fast I could moved, and many would congratulate me for my hard and dedicated work!

Regarding recordings in such "tablet", it would be "ideal" if it could record both side streams in a single SSD (Solid State Drive), but two (one for each side) would be perfectly understandable and acceptable for the time being.

Did I mention recording **Uncompressed Raw**? Preferably **Cineform Raw Uncompressed** or **CinemaDNG Uncompressed**.

For Cinema 3-D work, I would not use any Raw capture compression (until maybe for post editing and the final delivery step of course)

Uncompressed Raw will preserve the total maximum quality the sensors output are capable of, and even if you go the compression route in post, you would still have the "film negative" intact for possible future re-manipulation or editing. Film negatives aren't compressed, are they? Then, why Raw should be compressed??? Doesn't make sense at all!

Having an Uncompressed Raw workflow in post, is the best way to extract all the color information and dynamic range while preserving the cleanest "noiseless" images throughout all the editing "production chain". And be able to even do an extreme grading if you think that fits your look style and the story in a movie.

Color Depth: 8 bit, 12 bit and maybe 16 bit for those that like large numbers or compression on the fly...in my settings, I found not much visible difference in quality (nothing I would care for much anyways) between 8, 12 and 14 bit (over Raw 16) working with Uncompressed Raw/RGB footage. Except that they will increase the file size 1.5 and 2 times over 8 bit respectively. See the chapter "Uncompressed vs Compressed" for a comparison test.

Recording directly with compression though, a higher color depth is helpful and you will notice a difference in IQ (Image Quality) in the footage.

In post if you decide to go the compression route (after recording Uncompressed Raw 8 bit), then exporting to Cineform Raw is a good choice too.

Lenses, C-Mount. I prefer prime lenses. You only need 3 FL's for 99% of acting staged work. A wide, normal and a mid telephoto. In a 2/3" format, something like a 8.5, 12.5 and 25mm would do it.

If you want zoom lenses, (and can manage to perfectly match FL in both lenses) a 28-85mm constant lens aperture (in FF 35mm photography terms) would be workable too.

The Fuji 3-D 2/3" Zoom is a 7.5-30mm (24-96mm in FF 35mm) with a constant f2.8 aperture and will permit to work with a 60mm SB.

What else? Ah don't bother with "point of convergence" or "toe-in" adjustments in a 3-D camera, shoot parallel and then do HIT (Horizontal Image Translation) in post to get proper Stereo 3-D horizontal Parallax or NetD (Net Deviation) or "disparity" between the two sides percentages that are called for Cinema projection and TV displays.

Even if you lose some resolution doing so, in the final 3-D footage, the resolution will "make up" for itself when displayed in 3-D because of the double "overlapped" images.

I think that it's folks...if you don't like my idea of a "3-D Camera" and want something out of a Sci-Fi movie for example, then go watch a movie like that, there are plenty to choose from, or go read some internet forums...

Sometimes when I want to laugh a little bit, I go to some forums and read such threads of the "perfect" camera and TV that people wants and "cannot" fully enjoy life without...some of them are hilarious in their wishes!

It seems that most human beings are never satisfied with anything anyways, for example if they already have a "3", they are looking forward and sometimes anxiously waiting for a "6", even losing sleep over the matter, and in some extreme cases getting into fights with others in the internet (forums, groups, blogs etc) and in their homes with the "wife" ;-) (explaining why it's "important" such and such, and why such investment expense "needs" to be done...even if you need to refinance your house to get the "dream camera", it doesn't matter if "everyone" is using it to make it "big"...!) lol.

And then when they finally get it, is "not enough" after a while that either, so then they need a new "12"...and so on and so on...and it never ends!

My advice? Since I "been there done that" already, rent a camera instead!

Don't buy it if you cannot recover the investment in a reasonable time frame with paid work that you know for sure you will do. Don't base your investment "return" in an "I could rent it" plan-B, if I don't use it much for my own projects...seldom you will recover the investment that way if you are not a big rental house with years of presence and experience in the market.

Use equipment "depreciation" calculations in every single project you do or plan to do, to do so divide the total cost of the gear in the number of projects planed. That way you'll have your depreciation base "cost" per job.

Don't base the depreciation calculation only in a single camera; put all together, back up cameras, recording media, lenses, lights, (flashes in the case of photography) computers, software etc...All the tools you need to get the job safely done.

You'll be surprised that it's a huge amount of money "throw it away per job! When I did that with my photo and video equipment, I could not believe how expensive it was in reality!

That's why some experienced Cinematographer doesn't even own a single camera, they can be experts using many, but they aren't of their property, they are of other people or rented.

They know the “volatility” of gear and how fast it can depreciate. What is “hot” today tomorrow will be replaced by something “better”...

Anyways, I don't really know how I could have lived before the invention of the internet and forums...can't remember what I did before to have some much fun!

And to learn too, the internet it's a great tool for that...can't beat [Wikipedia](#)!

I started using the internet in 2001, just 10 years ago, and I think I have “seen” and learned more stuff in that term, than my previous 30 years of life combined!

Oh man, no wonder the internet it's a modern “addiction” for so many people!

Back to “gear” stuff, I am perfectly happy with something that is affordable for me, and that I know I can use to get the job done and make financial sense out of it (recover it's worth with paid work).

I don't even need an “HD” cam for a DVD delivery! (if the SD camera is 3 sensors, if it's 720p from a Bayer sensor, then yes the use of one of those is called for, or even if you are recording 1080p with a DSLR, to get rid of the aliasing that "line skipping" reading of the sensor causes with those cams, then down-converting to SD (720 x 480 pxs) is the way to go)

I still own and use my SD [Panasonic DVX-100](#) and DVC-80 (same cam, but only interlaced) camcorders. And my “consumer” 6 MP Nikon D70s (I have two of them). I gave the D40 to “the wife” so she can learn photography with it, and for taking pictures of the boys...(D&A)

I do use some "auto" with those cameras in fast paced shootings like events and others now (like chasing the kids to take photos and video), Auto focus and sometimes Auto WB (White Balance) when the programmed settings don't get it "right". So even though I am a "manual" guy for the most part, auto settings have their use in certain circumstances. Like when you are losing your vision like me because of so many hours staring at computer monitors (especially CRT's that are the best displays BTW) or are getting old (and lazy)...that's why I seldom use manual focus prime lenses for 2-D photography now...a zoom/auto focus will permit you to work faster and you will lose less important opportunities for "candy" moments.

My 2 [Sony A-300](#)'s for 3-D photography are not being replaced by anything yet either...until I can get manual controls and relatively clean ISO 1600 in a stereo digital camera, they are a “keeper” in my book as well. (The A-300 as the same as the D70/40 can do a clean ISO 400 tops for prints, but for small screen 3-D displaying you hardly notice the noise at ISO 1600)

For 3-D capture I still think that manual focus/ primes lenses is the best way to go. That's why I have my two Sony zoom lenses at 28mm fixed. You still can use auto focus with those cams, but sometimes it will fail to focus in the same subject/object as the two views have a slightly different perspective.

It was a hard decision for me to have to “let go” my Nikon D700 camera recently, but I hope I can “get it back” again in the future...after all, lots of people will “dump them” as soon as the D800 or whatever model shows up in the market to “replace it”. You've got to love [Craiglist](#) and [eBay](#)!

To conclude this article (that might be the “best” I've ever written so far, since includes almost everything I know in the biz)...Do you know that the first movie ever made was Stereoscopic (3-D)? Read here: (under History)

<http://en.wikipedia.org/wiki/Film>

“An 1878 experiment by English **Photographer** [Eadweard Muybridge](#) in the United States using 24 cameras produced a series of stereoscopic images of a galloping horse, is arguably the first "motion picture"

And I probably would say that a 3-D movie would be the last to be made too, but I don't think humans will stop making motion pictures ever...there is not "going back" once you discover certain things in life...

3-D Cinema is here to stay this time. In Spanish we have a saying: "La tercera es la vencida" something that could be translated to English like: "Third time lucky".

3-D will be the future of Cinema, TV, games, computer programs (including internet) phones, and any kind of display you can think of..., don't matter what the "naysayers" claim...

Now, like [Roger Maddy](#), a 3-D ol' pal says:

NEXT! :-)

Let's move on with another "puzzle" people!

PS. Finally, would all of this matter in ten years from now? In a hundred years? In a thousand years? Probably not, but it might be a necessary "logical" step to get to the better and "perfect" future 3-D camera systems!

I've been testing out Sony Vegas 11 for 3-D editing...and I could easily resume my impressions in a single word: WOW!

That \$550 USD (upgrade is only \$150) software is a good option for **Indie 3-D** movie producers! You can do almost anything you need to do in a 3-D editing environment. It'll take any resolution, any frame rate and almost any video codec in the market.

Where is Sony Vegas from?

Madison Wisconsin (at least their headquarters are there).

One very famous and well known Cinematographer in Hollywood, once told me that in Wisconsin there were only cows and people only made cheese there. Well he was right about one thing; Wisconsin produces the best cheese in the USA!

Now a day most people don't read History or care much about it seems...

I'll give you a short "ride" in 3-D History regarding Wisconsin...

1875 Wisconsin Dells WI. USA.

When **Mr. [H.H Bennett](#)** opened his photography Studio in Wisconsin Dells. That man revolutionized stereo photography forever. His work and techniques are the basis for many 3-D Photographers and Cinematographer. He was straight guy, parallel shooter, side by side, 1/30th rule. NO BS!

If you want to learn how to do 3-D properly, study Mr. Bennett's techniques and admire his beautiful stereo work. Then when you make your first Million bucks with your 3-D Cinematography work, please donate 1/30th of that to his **[H.H. Bennett Museum](#)** (that is struggling to survive, and if it wasn't for the Wisconsin State government, it would be closed by now)

1947 Milwaukee Wisconsin USA.

The David White Camera Company introduced the best selling stereo photography camera of all time, the venerable **[Stereo Realist](#)**!

I don't really know if modern 3-D digital camera manufacturers (still or video) are aware of the Stereo Realist, or know a thing about stereo at all!

What's that with some new cameras having 10mm Stereo Base? I just can believe it, it's beyond my comprehension and it's almost like a sub real nightmare that I want to wake up from!

2008 Cambridge Wisconsin USA.

The introduction of the first HD MVC's 3-D system.

Machine Vision Cameras are now used in Motion Capture 3-D, Stop Motion 3-D and Live Action 3-D Movies.

There is no doubt that digital camera technology has made possible movie making affordable for Indie movie producers, but not because you are not using film nor paying for film developing services, means that a digital workflow is free.

So just because you are shooting digital don't "shoot at will", and then "fix" all the mess in post...there you will pay a larger price, **time** in selecting what is going to "make it" in the movie and what not...and then all the time de-Bayering all your footage in post.

When I shot 35mm film in events photography coverage, I used to take around 4 rolls of film with 36 exposures each, a total of 144 pictures...all well planned. My final "target" was to sell only 106 pictures, and the rest 38 were just to be "safe" and give the customer more choices...well since like I said, all were "right on the money"...I've got that in return most of the time, and people would buy all of them at the end!

Even in some rare cases that I shot an extra 36 roll of film, most of them were "goners" too...good sells.

But when I started shooting digital photography, and I saw "no cost" on film and processing, I started to shoot a lot more...sometimes 3 or 4 times more pictures...450-600 and in some cases up to 900 pictures, what a nightmare! For me, for my photographed subjects and later on for them to choose from all of that!

A relatively easy task of choosing the pictures when they were less, now it had become into a task that required a **lot** of work for them to choose from, some of them even took months to decide what they wanted!

And the final results for my extra hard work and equipment shortened life for the increased workload?(that is the real price as well)

Most of the time they would buy the same as before...150 pictures in average!

What a....!

It was not worth it for me nor for them.

I've watched behind the scenes footage on movies where they shot hundred and hundreds of hours of footage...for a 90 minutes feature....it took them months of selective work alone (let alone the work while they were shooting it...) just to "isolate" the "good" from the bad...

Make yourself a favor and your crew/actors, don't make your and their life miserable doing this, select your shots carefully (well planned before shooting them)...and I know that actors are humans and hence no matter how professional they are, they are still imperfect and will make mistakes while shooting scenes...but still, that is different than shooting the scenes over and over just for the sake of it...

If your actors or production crew "don't get it right" in less than 3 tries, get others that are more focused (that is the term for "Professional" if you haven't thought about that yet).

Why do I mention this? Because when working with Uncompressed Raw the file sizes are huge in comparison to compressed video, so the transfer and storage of such files takes more time and a lots of space. Also when you are ready to save your final movie original files for long term archival purposes you will need a serious amount of LTO tapes to do so.

I don't mention all of them necessarily in order of “importance”, although the first ones at least are personally, but all of YOU are important for me. But maybe I will mention people in order of “appearance” in my life (at certain degree)...not perfect though, because I need to think hard for that and my brain might start outputting smoke for some much workload! :-)

First to my God, [Jehovah](#) who gave me my life (and has protected it since then), and all the rest of the blessings that comes with it. I love you my God.

To my parents **Hector** and **Catalina** who were the “conduct” of my existence, and especially to my mom whom carried me in her womb for 9 months before I was born, and then after that took good care of me when I could not do it by myself. I love you Mama.

And to my Papa for this new encounter after 39 years or so of being separated. This reunion is a miracle by itself, I wish I could enjoy you more and learn from you more...maybe in the New World that is coming?

To my aunt **Irma Margarita Sanchez** (RIP), who chose my names (Horacio Cesar) when I was born. I love you Tia.

To my beautiful boys **David & Alexander Rubio** who give me some much happiness, and hope to think that we humans can be better. Los amo mis muchachitos hermosos (I love you my beautiful little boys).

Children are the best people in the world, “Jesse” an old neighbor across the street from our home in [Wisconsin](#) told me once. He was right.

To my ex-wife **Heidi** for putting up with a crazy guy like me for so long (9 years), for that you deserve an award...a “Cesar 3-D” award. And also because you are the mother of the two human beings I love the most in my life...and are, and I know that you will continue to take good care of them in my “absence”. That is the most important “job” in a parent, to love, play and take care of their children...all their lives not just when they are “little”. A “work” that is more of a blessing and enjoyment than actual “work” as most people knows the term...I should share that with you at your side, but unfortunately I can't...for now...one day though, I hope I can take over my responsibility again, after all they will always be my sons. Forever, so a few years is “nothing” in comparison with an eternity...

Now to “business”...

I want to thank all these people for helping me to achieve this project to a successful term, since I started working on it on the fall of 2006. I could not have done it alone, it's too complicated for a single “man band”. I was never alone, and even when we think we are, we aren't. There's always some one with us at all times.

First to the [View-Master](#) company and [Stereo Photographers](#) of such beautiful reels when I saw when I was 7 years old. Especially to the ones that made the ones from “Heidi” the old movie, one of my favorites. When I saw my first reel, that was “it” for me, love at first sight with stereo images.

Then to Mr. [H.H.Bennett](#) from Wisconsin Dells WI. USA. who inspired me to find out more about stereo photography in 2003 when I visited his museum for the first time. I think it was an “accident” when I entered that museum for the first time (I did not know that it existed before) To “Charlie” who was in charge of the museum at the time (I hope I did not forget his name, and that's the right one...) At times I was the only one inside the museum, I felt like if Bennett was still there, I saw his photographic tools and reminded me of my own “rustic” studio of 1989. Every time I go there I feel great, and is one of my favorites museums.

To the **David White** company from Milwaukee Wisconsin that made the [Stereo Realist](#) camera, and it made me realized that a single man's idea can produce great and successful results when applied wisely.

Also to [George Themelis](#) whose excellent [book](#) about the Stereo Realist made me realized how proper stereo was recorded and what were the requirements for it. I saw the “Stereo Rules” in that book for the first time, and I think that's the only time since nobody talks about them on the internet (besides me)...a book well explained and simple. Just like things should be. After reading that book, I “was ready” for the next thing...

From [Norpix](#), **Luc Nocente** CEO, **Debie Belafi** the office manager, **Mihaia Ghita** and the rest of the software team, especially thanks to **Phillip Candelier** who is an extremely talented hardware engineer and a dear friend of mine.

From [AVT](#) (Allied Vision Technologies): **Michael Cyros** North America CEO, **Scott Smith** sales engineer, and later on from the Prosilica acquisition **David Frosini** a sales engineer as well. (I think he is at 1st Vision now...but I might be wrong)

From [1st Vision](#), **Tom Russell**.

From [Cineform](#), **David Taylor**, **David Newman** and her former office manager **Mary Reeves**, a lovely and warm lady.

To [Sumix](#) personnel, that sent me one of their cameras for testing purposes.

From [Uniforce](#), to **Sudeep Gonsalves** for all his help with the IO Industries DVR recorder.

From [IO Industries](#) to **Adam Little** and **Andrew Searle**.

From [Ximea](#) to **Michael Cmok**.

From [Phase 1 Technology](#) to **Auralee Ponce de Leon** for her help with the Dalsa Falcon2 cameras.

To [Josh Klatt](#) who was the first person to trust in me and in my project, doing so you were blessed as well, because you were the “**numero uno**” using MVC's for **Live Action 3-D** productions. Courageous acts also deserve great recognition.

To the [3-D Center of Art and Photography](#) in Portland Oregon USA, where they took care of my “baby” for 18 months or so...Especially to **Shab Levy** who personally went to receive the donation of it to our humble home in Wisconsin in early 2010. Then he took all the family to my wife's favorite restaurant, the “[Olive Garden](#)”. Thanks Shab! And to **Rob Kriesel** who kindly offered the system back to me, when they closed the Center recently in 12-31-11.

To all the [Starbucks](#) people at the **Bellflower CA** branch (Rosecrans and Bellflower) who did not have an idea what that “crazy” guy was doing all day long connected to the free internet...love them all, nice people who do more than serve delicious coffee. Also the other branch at Alondra and Lakewood that I went a few times as well.

Thanks to the [Los Angeles County public libraries](#) system (in Bellflower) that I would go to use the internet when I was ashamed to return to Starbucks sometimes after being there for most of the day (without eating many times, no wonder people think that I am crazy, because you have to be crazy not to eat for long hours while you are “working”...:-) But who thinks in food when they are “having fun”?...they need to be reminded of that by something that never lies...our empty and hungry stomach.

To all my internet “buddies” who had to put up with my craziness as well and I have learn a lot from...especially to [Werner Bloos](#) who led me to the 3DTV Yahoo group in the summer of 2006, then to “**gl**” (I don't know his complete or real name) in the same group and [Dimitri Papadopoulos](#) at the Linkedin group “Stereoscopic 3-D Professionals Worldwide”, you both were the ones suggesting me to write a book, at first I thought that it was a

“crazy” idea, but now looking in retrospective it was not such a bad idea after all! Thank you guys! Even the use of MVC's for 3-D cinema seemed “crazy” at first...but now?

To [Steve Jobs](#) whose speech at Stanford University in 2005 (I later on watched it on Youtube, like in 08-09 I think) inspired me to continue regardless that almost every one thought that I was “crazy”).

And also a big thanks to **all** [Cinematographers](#) who have inspired me through out my life with their movies (2-D & 3-D), there are so many that I can not write all of those movies in this document. But you know who you are and you don't need a poor guy like me to thank you for your wonderful work.

Sorry If I forgot some of you who are important in my life and have helped me trough out my life, you know who you are and with my work you are part of that success as well.

Finally, to all my **dear Friends** and **Brothers** in life. You know who YOU are too.

Cesar Rubio.

Thank **YOU** for reading this e-book. That means a lot for me, to know that other people can benefit from my work and experience on the field so far.

If you found something useful in this e-book (or else in the internet that I've written in the past 5 years or so, and are thinking that the next time "I visit your town" you might want to invite me a drink, please instead of that donate the price of a drink or two in a bar to my beautiful boys **D&A Rubio**. They need more the food than I need the drinks. Even a \$5 USD donation will be well appreciated.

But if you think that this e-book has saved you tons of money and time in research trying to figure it all out by yourself, and want and can do a larger donation than that, [Jehovah God](#) bless you for that.

If you are running a multi million dollar corporation, and think that my work has saved you lots of money in equipment purchases, and has help you to do things better, a donation that it's tax deductible wont cause your company to go bankrupt. It's either that, buying more gear or giving it to the "government" in taxes, you decide who deserve it more. That also applies if I am giving your company "free advertising" for your products, and you start to see sales increases "all of the sudden"...

Giving to the poor always brings happiness and blessings along with it (I did not say this first, some one else BIGGER than me or anyone who has ever lived on this world by that matter, say it before, it was our lord [Jesus Christ](#))

Consider other poor people for donations every year as well, and while you are thinking about them, please think about my two kids too, they are poor and soon will be left with out a father...(the terrestrial one, because the heavenly one will be with them always).

I was diagnosed with Schizophrenia in early 2010, and given my personal circumstances that "makes sense", but it was a wrong diagnosis. I have bipolar disorder, sometimes I suffer from chronic depression and sometimes I am in a "high mood", in the latest is when I have achieved most of my work in this project.

I still could work with that no problem, the real problem is that there are powerful interests in the biz that don't want this project to succeed...or at least not with "wide open" knowledge, either because it competes with their more expensive products or since some companies are already using it for their own productions, and everyone wants to keep the "best weapons" for themselves.

Some people have been planning to "disappear" me for more than two years now, and sooner or later they will succeed. That's why I closed the forum about this project in early 2010 (www.davidrubio3d.com) and stopped selling MVC's 3-D systems. They are too powerful for a "single man" to fight them. It's like micro-[David](#) vs extremely GIANT Goliath, or many of them together not just one.

If I was the real biblical David I would not be worried at all, but the sad thing is I am not. I am not even close to the man he was, and hence I don't deserve the blessings he had while he was living either. I am just an "average Joe" with all the good qualities and shortcomings...

Please send your donations or even a thank you note with out any money if you cannot do it at this time, to my sons **David and Alexander Rubio**, they are 5 and 4 years old, they are so "defenseless", innocent and pure. Just a couple of **beautiful** human beings...like all kids are.

So they can see one day that their **PA-PA** was not an irresponsible parent. I care for them a lot, and I started this project besides my love for 3-D, mainly because of them, trying to give them a "better life". But in the way of trying to do that, everything got "messed up"...

All the money of your donation will be for them, I won't take a penny from it. I wont be needing any money soon

to the place I am heading anyways...any large donation of over \$200-300 USD will be issued a “receipt” from **Heidi** who is the parent with legal custody of them.

Please send an e-mail to find out how you can send your donation here:

dna-rubio-s3d@live.com

Thank you very much, and **Jehovah God** might bless you for your Generosity!

Especial thanks to **Benoit Michel** of **Stereoscopy News** (Belgium), to **Ronald Kriesel** of the **3-D Center of Art and Photography** (USA), and to the **Internet Archive Org.** that are offering this e-book for download. And to all people who are passing it, in one to one basis...many thanks to you all.

Cesar Rubio.

You can distribute this book or info in this e-book (including images) anywhere you want, even if you write a book about 3-D cinematography and want to include some of the info in your book. Even if that book is not free, like this one. Just please acknowledge the source of the info. You can also translate this book to your own language, and please consider distributing it for free as well if you can...I would translate it to Spanish, but since I don't have a way to check and correct my bad orthography...and I am running out of time here...I will leave it to some one else to do that.

You can also use the info here as the “blue print” of your 3-D system if you think my proposed **Vision Stereo 3-D Cinema** camera system, can be successful in the future and want to “give it a try”. If you name the first model as **D&A R-3D** (or at least mention that you've got the idea from this “model”), it will mean the world for my boys one day!

Finally you can put this e-book for download in your site if you read it, like it and want to do that.

But since I mention God a few times here, some might find that is not “Professional” to mix “religion beliefs and business”...I think the contrary, if all people did that, this world would not have the deep economic problems and other kind of troubles that derivates from it, that it has or has had during human history (this is nothing new)...

But who I am to teach the world a lesson? When I failed to teach myself the most important lesson of all...

Also since I am too strong “opinionated” in certain things, some don't like that and if I got into trouble for that, they might be afraid to get in the same “harms way”...but I agree that for the most part, is relatively “easy” to “take down” a single man and his ideas, but It's not so easy to take down many of them...especially if they are from all over the world.

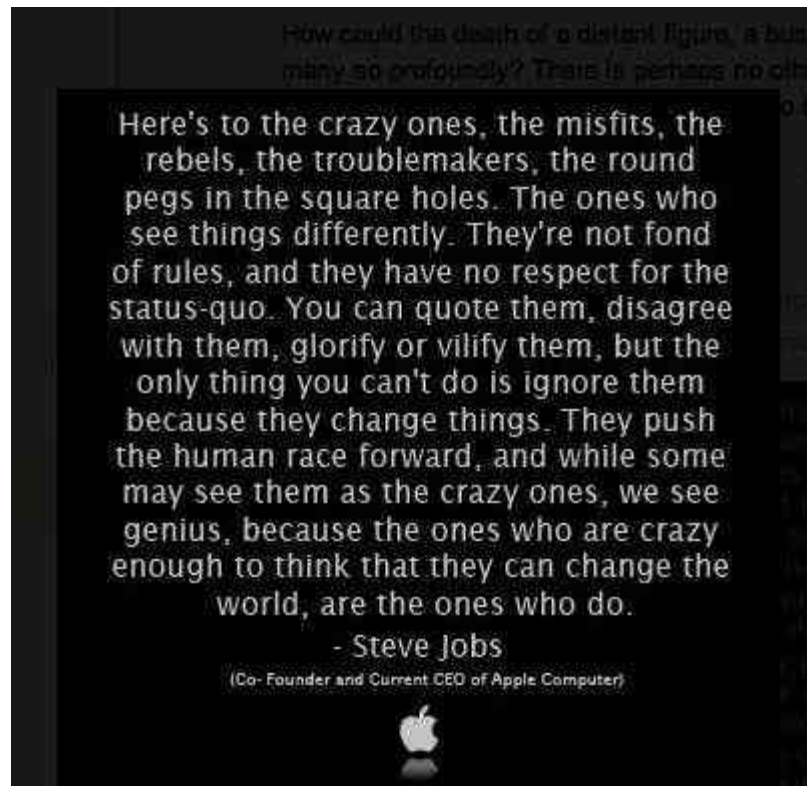
And if this book has God's blessings, no one ever will take it “down” just like the things He protects...like His own book the [Bible](#). This is nothing comparable with that wholly book, but it's also important for me and one day it might be important for my boys too. I will send it to them first before to anyone else. Actually they might be the only ones that will read it completely one day...(besides me). So this might be my “diary” with work related issues and other “crazy” things...time will tell what it is, if is just that, or has more “relevance” than that.

Even though this is an "unfinished" book, like my life will be and others lives have been like in the case of [John F. Kennedy](#).

And since I was created as a “reflection” of [Jehovah God](#) (you were too), He knows and respects our work and bless it if it's with good intentions. Even when we have “deviated” a little from His paths...or a lot like me. Almost every one deserves forgiveness...even a guy like me (when asked for, and there is still time to be granted...).

If you have any questions regarding this e-book you can contact me in my [Facebook](#) or [Google+](#) pages.

Thanks,
Cesar Rubio.



RIP Mr. [Steve Jobs](#), I am **crazy** enough to think that **I might see YOU** again, doing genius things...in the not so distant future...both alive and awake, since you are already "asleep" and soon I probably will be too.



Sofia

The most beautiful, and courageous animal I ever known. She died defending her babies from a two dogs attack. But she saved them all...none of them were hurt.

Her "husband" was **Nino**, an extremely beautiful and intelligent animal also.

Their babies names, **Wilson**, **Roberto**, **Olivia** and **Maribel**.

She is buried in the same place where I took this picture, in our home in Wisconsin. I hope I will see her again soon...

Photo taken in 2004.



Heidi

My love, and mother of the two beautiful human beings that I love the most in my life, **David & Alex Rubio**.

Photo taken: in Mr. Bennett's Studio in Wisconsin Dells WI in 2003.



Charlie

The best tour guy I ever known. He's got one of the best jobs in the world. In one of the few museums about 3-D Photography in the world, at the [H.H. Bennett Museum](#).

He is also one of the warmest and friendlily humans being I ever know, he gave Heidi and I a "personal" tour the first time we visited the Museum. We were the only ones inside...everything just for us, how good is that?

Excellent!

Photo taken: 2003.



[H.H. Bennett Museum](#)

Me in the first visit I made in **2003**, and it was the inspiration to start my career as **Stereographer**, although I loved 3-D since I was 7 years old (in 1978), obviously I did not know exactly how Stereoscopic pictures were taken back then, and it wasn't until that day in 2003 when I was 32 years old, when everything "came back to me" again...the LOVE and a renewed HUGE interest in 3-D!



Mr. [Henry Hamilton Bennett](#)

Mr. Bennett (sat on the right) was the man who invented the **Stop Action Shutter** in Photographic cameras.

He also invented the **Photojournalism** style, with his work on men working cutting lumber by the Wisconsin River.

He also was the one who made [Wisconsin Dells WI](#) famous withy his beautiful Stereo Photography work in the area.

I love all his Stereo work, especially the "**Ice Palaces**" work in Minnesota.



[Large Format Photography](#) Camera

Me with **Mr. Bennett's camera**, just the way how I started my Professional Photography career when I was 18 years old, back in **1989**.

Photo taken: 2003



Tety

A 3 years old, beautiful, innocent and curious boy...

Photo taken: in 1974?



Catalina

My beautiful **Mother**, who conceived my life, took care, and has loved me since she found out I was in her womb...TE AMO MAMA!

Photo taken: 2005



David & Alexander Rubio

Me with the greatest loves and inspiration of my life, my beautiful boys **D&A Rubio**.

This was our last "Studio" picture taken in our **home**, in Wisconsin in **February 13th of 2011**.

My best wish is to be able to see in person, hug, kiss, play, read stories, **pray** and enjoy my life with them again. And I hope that after that, nothing and no power on this world will separate us **ever** again.

That day will be the continuation of the happiest period of my life...

If I am going to **live forever** one day, I want to share my whole life with them.

And even if "I don't make it" there, I will be **happy knowing** that they did make it!

If they live forever, I will too...**in their minds and hearts**.

PA-PA.

It's the long term experience of problem solving that makes you successful! & what we do in life, echoes in eternity.

“No army can withstand the strength of an idea whose time has come” -[Victor Hugo](#).

[**2018?**](#)

